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1 May 2006

GUIDE TO MOBILE AIRCRAFT ARRESTING SYSTEM INSTALLATION

DEPARTMENT OF THE AIR FORCE

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BY ORDER OF THE SECRETARY OF THE AIR FORCE

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Operations

GUIDE TO MOBILE AIRCRAFT ARRESTING SYSTEM INSTALLATION

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This handbook addresses actions necessary to install a Mobile Aircraft Arresting System (MAAS), including installation with the Lightweight Fairlead Beam (LWFB), standard fairlead beams, and Mobile Runway Edge Sheaves (MRES). A MAAS may be installed to meet a wide range of uses, such as an airfield survivability arresting system (for use on a bomb damaged runway), as a bare base asset for overseas deployment, or for emergency or contingency use at an established base. Users of this handbook include power production personnel and installation team augmentees. In addition, provided information is relevant for advance team and control center personnel involved in the planning and beddown at an installation or bare base. Installation team members should have a basic knowledge of the system and its operations and maintenance requirements. At least one installation team member shall be a tasked-certified Electrical Power Production Craftsman, 3E072, who will certify the newly installed system ready for use per AFI 32-1043, *Managing Aircraft Arresting Systems*, paragraph 1.2.4.4. After initial certification, a task certified 3E052 Journeyman may perform after arrestment inspection and certify the system back in service. Refer to the applicable system technical order for removal procedures. The guidance is based on T.O.s 35E8-2-10-1, 35E8-2-5-1, 35E8-2-11-2 and 35E8-2-3-1; UFC 3-260-01; AFI 32-1043; and Engineering Technical Letter (ETL) 98-10. This handbook provides guidance; it augments and integrates the four applicable Technical Orders. The Technical Orders remain the final authority for de-

tailed installation, operation, and maintenance. Electronic links to references can be found in Attachment 1. ***NOTE***: Ensure all records created as a result of processes prescribed in this publication are maintained in accordance with Air Force Manual (AFMAN) 37-123, *Management of Records*, and disposed of in accordance with the Air Force Records Disposition Schedule (RDS) located at **https://webrims.amc.af.mil**.

SUMMARY OF REVISIONS. **This document is substantially revised and must be completely reviewed**. Of major significance is the addition of Chapter 4, Mobile Runway Edge Sheave (MRES).

Page

Chapter 1

MOBILE AIRCRAFT ARRESTING SYSTEM (MAAS)

1.1. Introduction. The MAAS consists of two identical mobile units (**Figure 1.1**). Each unit houses a 52-W-2291-901 BAK-12 rotary friction energy absorber; contains all basic components of a fixed base arresting system, and all the tools and hardware necessary for installation and removal; except for installation on soils with a low bearing pressure. The equipment and tools also support the Lightweight Fairlead Beam (LWFB), Mobile Runway Edge Sheave (MRES), and standard fairlead-beam installations. The MAAS easily transports over land or by military airlift. However, because the tires are foam filled to prevent flattening by puncture, they have a run time limit of 35 MPH with intermittent speeds up to 55 MPH for a period no longer than two hours (constant) or the heat will cause the foam to revert to a liquid state and possible cause the tires to explode. If these speeds and times will be exceeded (such as transport for exercises), recommend the MAAS be loaded for transport on flat be trailers.

Figure 1.1. MAAS Trailer in Tow.

1.1.1. Background. Prior to the development of the MAAS, a fixed BAK-12 based system was the prime AF expeditionary aircraft arresting system, which required more than 100 man-hours to install (**Figure 1.2**). The original MAAS design was for a rapid installation emergency system to recover

fighter aircraft returning to, and launching fighter aircraft from, a battle-damaged airfield. In its unidirectional configuration, a 12-person installation team can install the MAAS in less than one hour (**Figure 1.3**).

Figure 1.2. Expeditionary BAK-12 Installation in Progress.

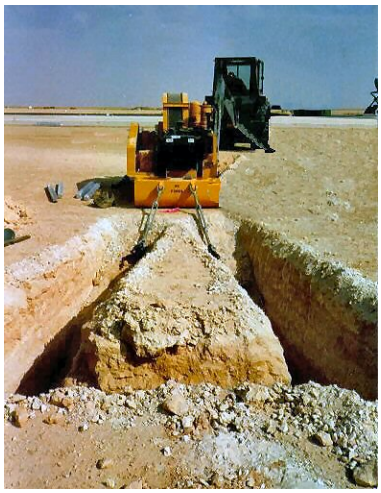


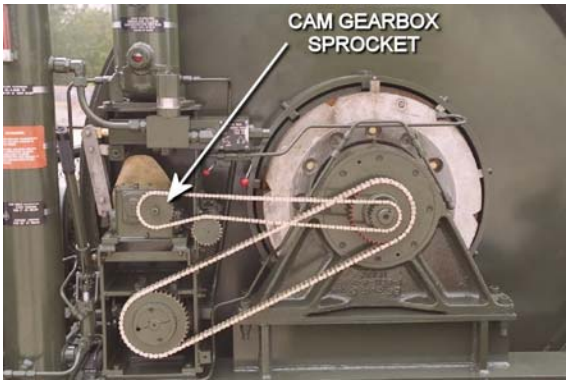
Figure 1.3. MAAS Installed on Concrete.

1.1.2. Capabilities. The MAAS is capable of arresting specified fighter aircraft within a nominal 990- or 1,200-foot run-out, depending on its configuration. The MAAS installation can be configured: 1) for unidirectional or bidirectional engagements; 2) For rapid recycle operation to rapidly recover aircraft; 3) With either the LWFB, a standard fairlead beam, or MRES to provide increased runway setback distances for safety clearance; 4) On concrete, asphalt, and soil surfaces.

1.1.2.1. The energy absorbers may be preset to 40,000-, 50,000-, or 65,000-pound weight settings. With upgrade configuration sets, field adjustment of the system allows arrestment of heavyweight fighter aircraft. The LWFB, MRES, or standard fairlead beams are compatible with either MAAS configuration**.**

***NOTE*:** In the heavyweight configuration, (or when installed with standard fairlead beam, LWFB, or MRES) change the cam gearbox sprocket (**Figure 1.4**), tape stack height, relief valve pressure, and synchronization pressure per T.O. 35E8-2-5-1. In addition, replace the 1250-foot purchase tapes with 1500-foot tapes to accommodate the full 1,200 foot run-out.

Figure 1.4. Cam Gearbox Sprocket.



1.1.3. System Upgrades. Initially fielded for airfield survivability, systems came with unidirectional configurations only. The part number (P/N) 52-F-1000 configuration set upgrade, provides all components needed to anchor

the MAAS and increase system run-out for heavy weight aircraft. Trailers with 19 stakes contain hardware for unidirectional soil and asphalt-over-soil installations. Trailers containing 25 or 31 stakes contain hardware for bidirectional soil and asphalt-over-soil installations.

1.1.3.1. Available upgrades to the system include replacement of the original Wacker hydraulic tools with newer Stanley tools (**Figure 1.5**). Engineering Technical Letter (ETL) 98-10 provides a full description of the new tools and the installation hardware included in the upgrade, to include ordering information (http://www.afcesa.af. mil/userdocuments/publications/ETL/ETL%2098-10.pdf). An upgraded system eliminates the need for the 8-foot ancillary hoses to raise and lower the trailers. All new systems from the factory are shipped with Stanley diesel/multi-fuel powered hydraulic power units or HPU's (**Figure 1.6**), and Deutz diesel (multi-fuel) rewind engines.

Figure 1.5. Stanley Tool Upgrades.

Figure 1.6. Stanley Diesel HPU.

1.1.4. Equipment and Tools. Each MAAS comes with the following equipment and tools stored onboard the trailers (**Figure 1.7** and **1.8**):

1.1.4.1. Soil installation tools, supplies, and components

1.1.4.2. Concrete tools, supplies, and components

1.1.4.3. Asphalt tools, supplies, and components

1.1.4.4. Cruciform stakes and moil points

1.1.4.5. Two hydraulic power units (HPU) with 50-foot quick disconnect hydraulic hoses

1.1.4.6. One hydraulic breaker

1.1.4.7. Two hydraulic stake driver

1.1.4.8. Two hydraulic hammer drills

1.1.4.9. Two hook cables (153- and 90-ft)

1.1.4.10. Stake installation work stands (not needed with Stanley tool upgrade)

1.1.4.11. Stake puller kit

Figure 1.7. MAAS Equipment—Elevation View.

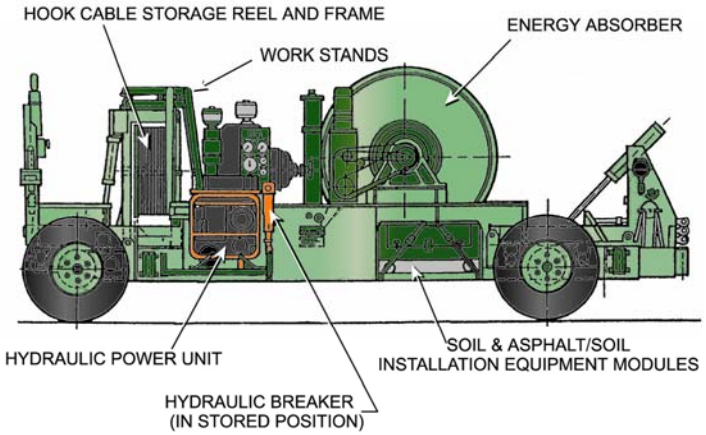
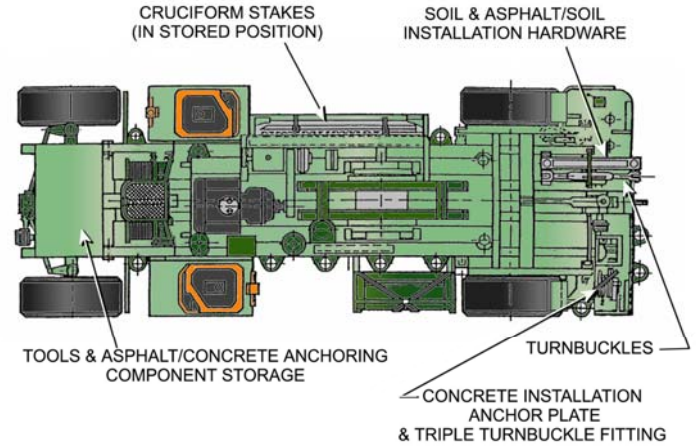


Figure 1.8. MAAS Equipment—Plan View.



1.1.5. The following installation configurations require additional equipment and hardware not included with the MAAS.

1.1.5.1. An installation site containing soil with a California Bearing Ratio (CBR) of less than 7 requires use of a deadman anchoring kit and heavy earth moving equipment (see paragraph 1.14.).

1.1.5.2. Bidirectional concrete installations require an additional concrete anchor kit if not already fitted with an upgrade kit (see paragraph 1.8.).

1.1.5.3. When additional wing clearance for wide-bodied aircraft is necessary, a LWFB, MRES, or standard fairlead beam kit will be required (see Chapters 2 and 3). In addition, heavy material handling equipment is required to unload and place the standard or lightweight fairlead beams. The MRES is towed into place, eliminating the need for a forklift.

1.2. Installation Planning. The particular operational need will dictate the location of anticipated sites. Personnel familiar with operational requirements must select the particular system configuration.

CAUTION

Notify Airfield Operations of any system irregularities and/or obstructions on or near the runway.

1.2.1. Operational Requirements. Certain aspects of flying operations may dictate a specific MAAS installation configuration.

1.2.1.1. An installation at home station may be needed in certain cases. Request information from Airfield Operations personnel about the types of aircraft that will use the airfield; their landing/takeoff speeds and weights; and whether or not the standard setback (275 feet from runway centerline) will be necessary. This information will help determine the temporary arresting system installation configuration.

***NOTE*:** When temporarily installing a MAAS at permanent installations, plan for a setback installation using fairlead beams or an MRES to comply with airfield-obstruction reduction initiatives. If standard setback and grading requirements can not be met (as outlined in AFI 32-1043 and UFC 3-

260-01), a waiver is required in accordance with UFC 3-260-01, *Airfield and Heliport and Design,* Attachment 2.

1.2.1.2. If deployed to a bare base situation, you may face wartime bomb or missile damage at airfields supporting AF, Navy, Marine, and allied aircraft operations. Therefore, you must be prepared to face different:

1.2.1.2.1. Recovery and abort weights

1.2.1.2.2. Length requirements for touchdown zones

1.2.1.2.3. Sortie generation and recovery rates

1.2.1.2.4. Runway operating surface widths and arresting cable lengths

1.2.2. Site Selection. Select installation sites that give an adequate paved surface for unobstructed aircraft run-out and a means for aircraft to exit the runway for additional incoming flights. Provide sufficient run-out to ensure the aircraft stays on the paved surface during arrestment and does not conflict with obstacles or other aircraft arresting system cables that may damage the tape.

1.2.2.1. Based on the above information, the Wing or Installation Operations Center should pass information through the Survival Recovery Center (SRC) or the CE disaster control center (DCC) in order to make appropriate MAAS installation, operation, and maintenance decisions. Siting considerations that may affect your site preparation, installation, and operation are:

1.2.2.1.1. The need for additional wing clearances for wide-bodied aircraft

1.2.2.1.2. Purchase tape and cable lengths

1.2.2.1.3. Unidirectional or bidirectional engagement requirements

1.2.2.1.4. Requirement for rapid recycle operations

1.2.2.2. Upon receiving the MAAS installation location coordinates, identify the surface type and installation method required. The basic types of surface installations are:

1.2.2.2.1. Concrete or concrete with asphalt overlay of less than 1inch.

1.2.2.2.2. Asphalt over concrete (asphalt overlay greater than 1 inch).

1.2.2.2.3. Asphalt over soil.

1.2.2.2.4. Soil.

1.2.2.2.5. Permanently frozen (Permafrost) soil.

1.2.2.2.6. Low bearing pressure soil (less than CBR 7).

1.2.3. Soil Conditions. The identification of soil type and its suitability for a particular installation is most important. Soil with a minimum CBR of seven is acceptable for a MAAS installation. A deadman anchoring system may be suitable for low bearing pressure soil with a CBR less than seven. Low bearing pressure soils are usually either a native soil that is fine-grained with mostly organic clay or a combination of clay and silt, or soils that have been disturbed by bomb craters or previous barrier installation operations. Both conditions can create poor quality soils with low bearing pressure.

1.2.3.1. Performing a full CBR test may not be possible during a deployment, but an engineering craftsman trained in the use of a Dynamic Cone Penetrometer, which provides comparable readings, can determine soil suitability. As part of bare base planning, conduct a pre-site survey that includes identification of low bearing pressure soils.

1.2.4. Differing Site Conditions. Elevations, slopes, and soil conditions can vary along the length of the runway surfaces and taxiways. Avoid locating the MAAS where tape interference with obstructions during arrestment and tape rewind is obvious. If site selection decisions did not account for site condition problems, inform the CE control center or DCC of the situation immediately.

1.2.4.1. Site selection decisions should consider additional resource requirements when installing the system on unprepared surfaces; especially when heavy equipment operations are required to remove soil crowns, projections, deep ruts, craters, and/or crater upheavals that may interfere with tape run-out and rewind. In addition, heavy equipment will be necessary to eliminate transverse slopes exceeding MAAS operating limits.

1.2.5. Manpower Requirements. Various factors will dictate the installation crew size. The MAAS Crew Chief has overall responsibility for the safe installation and must use all personnel effectively. Ensure personnel are aware

of hazards and use appropriate personal protective equipment (PPE). The Crew Chief directs team members to perform different installation steps simultaneously in order to minimize installation time. Training, practice, and safety are essential for efficient installation of the system.

1.2.5.1. Rapid Installation. Rapid installation (less than 37 minutes) requires a 12-person crew divided into three 4-person teams. **Table 1.1** identifies team breakout and task responsibilities. A crew of this size is unlikely unless under combat or emergency conditions, when launch and/or recovery of fighter aircraft is imminent.

Table 1.1. MAAS Rapid Installation Team Breakout.

Qty.	*Personnel*	*Tasks*
1	Barrier Crew Chief (3E072)	Direct installation
	(Must be task certified)	Assist Barrier Crew
3	Barrier Crew (3E0X2)	Locate MAAS and installation site
		Install hook cable
		Operate MAAS hydraulic system and BAK-12 absorber
8	Heavy Equipment Operators (3E2X1) two 4-person teams	Clear tape sweep area & installation site of debris & obstructions
		Prepare site surface for installation
		Install installation hardware

1.2.5.2. Typical Installation. The typical installation consists of six well-trained individuals. **Table 1.2** identifies team breakout and task responsibilities. This team can install a MAAS in less than two hours under ideal conditions. It may take longer when:

1.2.5.2.1. Site preparation is required

1.2.5.2.2. Poor soil conditions exist requiring use of deadman anchors or concrete foundations

1.2.5.2.3. Extreme weather conditions are present

1.2.5.2.4. Wearing chemical-biological protective clothing

Table 1.2. MAAS Typical Installation Team Breakout.

Qty.	*Personnel*	*Tasks*
2	Barrier Operators (3E0X2) (Must be task certified)	Directs initial placement and alignment of trailers Operate MAAS hydraulic system and BAK-12 absorber Directs and assists team members Remove or direct removal of airfield lighting in tape sweep area
4	Installation team members (Any AFSC) Two 2-person teams	Install installation hardware Clear tape sweep area & installation site of debris & obstructions Install hook cable

1.2.5.3. Alternative Team Sizes. For faster installation times, especially on soil or asphalt over soil base, using two additional persons to provide two 4-person teams will allow simultaneous installation of both trailers. When time is not a factor, a single 4-person team can accomplish an installation.

1.2.5.4. Specific Skill Requirements. In certain installation situations, heavy equipment operators (3E2X1) are required whenever:

1.2.5.4.1. Deadman anchors are required for low bearing pressure soils.

1.2.5.4.2. Large debris removal required in installation areas.

1.2.5.4.3. Tape sweep areas require grading and/or leveling to prevent the purchase tape from colliding with obstructions.

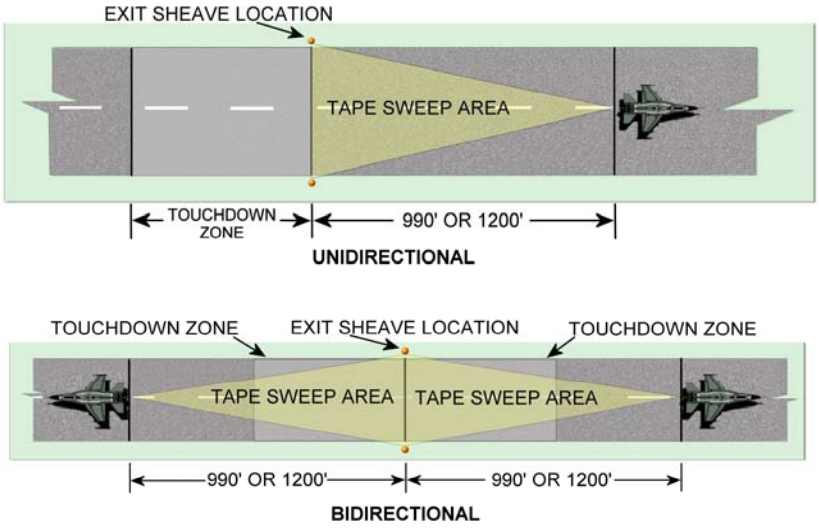
1.2.5.4.4. Ground slope near trailers require adjustment to meet MAAS and fairlead beam installation requirements.

1.2.5.4.5. Shoulder build-up near runway edge required for runway edge sheave to be equal to or slightly higher than the runway surface.

1.3. Site Preparation. Site preparations consist of selecting an existing suitable site, with suitable CBR, or altering site to suit the MAAS installation requirements.

1.3.1. Clear Tape Sweep Area. It is necessary to avoid locating the MAAS such that there will be tape interference with obstructions and sharp objects, such as stones and airfield lighting fixtures, during arrestment and rewind. The minimum area swept by the tape can be determined by sighting a straight line from the exit sheave position to a point 990 feet or 1200 feet down the centerline of the runway in the direction of aircraft travel (**Figure 1.9**).

Figure 1.9. Tape Sweep Area.



1.3.2. Clearing and Angle Adjustment. It may be necessary to perform minor leveling of the soil around and under the MAAS to prevent interference of the tape path. The edge of the runway surface must not extend higher than the MAAS exit sheave (**Figure 1.10**). Additional filling, leveling, and compacting are required to bring the runway shoulder to an acceptable grade if it is lower than the runway surface.

1.3.2.1. It is desirable for the angle of the tape centerline when exiting the edge sheave to project through a window 1 to 4 feet above the runway crown (**Figure 1.11**). An exception to this rule is when a minimum operating strip

(MOS) is laid out offset from the existing crowned runway centerline. In this case, the tape path projection should intersect above the new MOS centerline between 1 and 4 feet. It is not necessary that both tape projections meet at the same height. Under no circumstances should trailers be inclined so that the tape path projection is towards the runway surface.

Figure 1.10. Proper Edge Sheave Clearance.

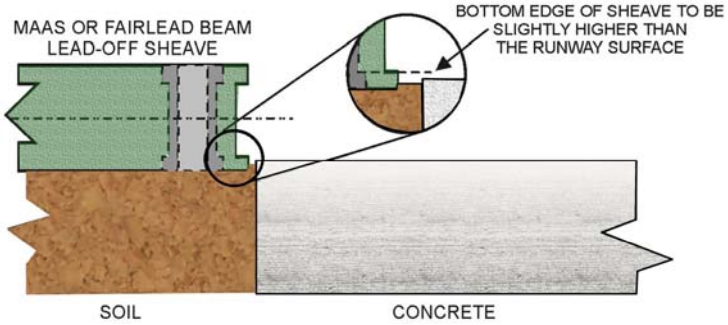
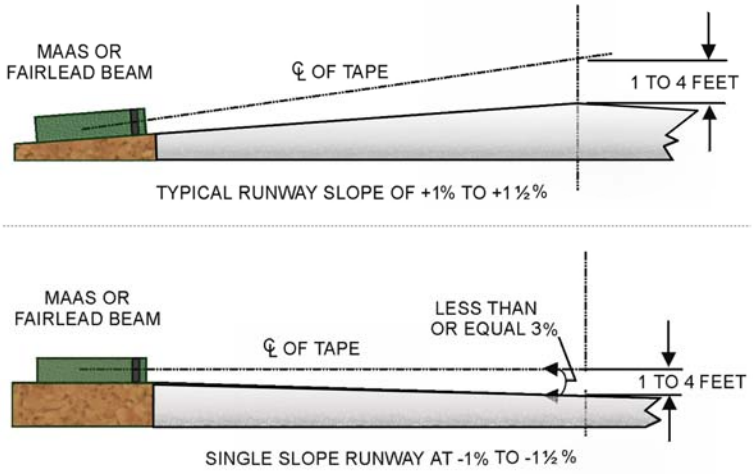


Figure 1.11. Projection of Tape Centerline above Runway.

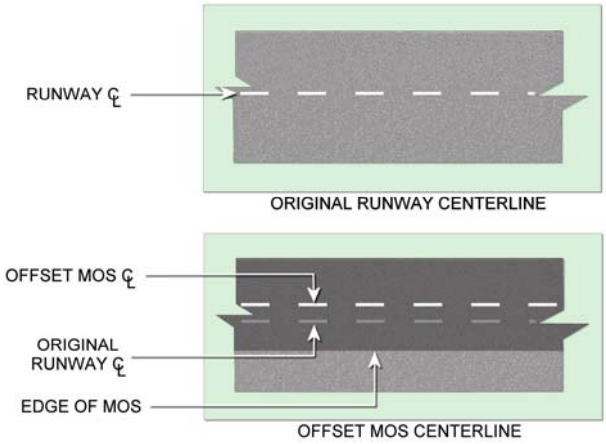


1.3.2.2. Slope of the tape centerline projection must not exceed transverse runway slope by more than 3% on runways up to 200 feet wide. The slope must not exceed the transverse slope by more than 2.3% for runways up to 300 feet wide.

1.4. Site Layout. The basic configuration and location for the MAAS is based on operational needs and siting requirements provided by the Wing or Installation Operations Center. The following information must be available for the setup and installation of the MAAS.

1.4.1. Identify Cable Location and Direction of Aircraft Travel. The minimum operating strip (MOS) centerline may be the existing runway centerline or the centerline of an offset portion of the runway (**Figure 1.12**). Ensure all installation personnel are aware of the MOS centerline location when siting the MAAS.

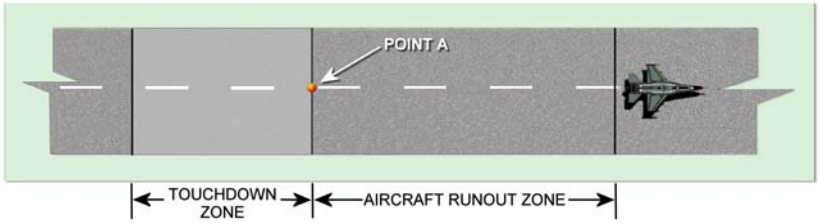
Figure 1.12. Centerline of Runway Operating Surfaces.



1.4.2. Unidirectional Layout. Locate the centerline of the MOS and the end of the touchdown zone. The intersecting point of the centerline with the end of the touchdown zone becomes **Point-A,** where the cable crosses the runway perpendicular to the centerline (**Figure 1.13**).

***NOTE*:** Contact Airfield Operations to get the minimum touchdown zone distances for the type of aircraft expected to use the runway. Protruding objects, excessive paint build-up, excessive joint sealant material, warped sacrificial panels, and undulating surfaces are detrimental to successful tail hook engagements and are not allowable within 60 meters (200 feet) of pavement on both the approach and departure sides of the arresting system pendant for a width equal to the off-center engagement capability of the system. In addition, changes in pavement type or an interface between rigid and flexible pavements are not permitted within 60 meters (200 feet) of arresting system cables (this does not apply to installation of sacrificial polyethylene panels or to emergency systems located within the overrun, but should be considered when selecting the site for a temporary system). Rigid inlays must not be used as a surface repair material beneath the cable in a flexible runway system.

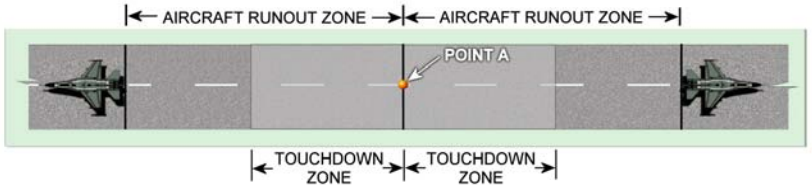
Figure 1.13. Establishing Centerline Point-A—Unidirectional MOS.



NOTE: LENGTH OF TOUCHDOWN ZONE DETERMINED BY INSTALLATION OPERATIONS CENTER

1.4.3. Bidirectional Layout. The cable is located where adequate aircraft run-out zones are available in both directions. **Point-A** is located on the centerline where the two run-out zones meet (**Figure 1.14**).

Figure 1.14. Establishing Centerline Point-A—Bidirectional MOS.



NOTE: LENGTH OF TOUCHDOWN ZONE DETERMINED BY INSTALLATION OPERATIONS CENTER

1.4.4. Locate End of Aircraft Run-out Zone. Depending on system configuration, select a point 990 or 1,200 feet down the MOS centerline.

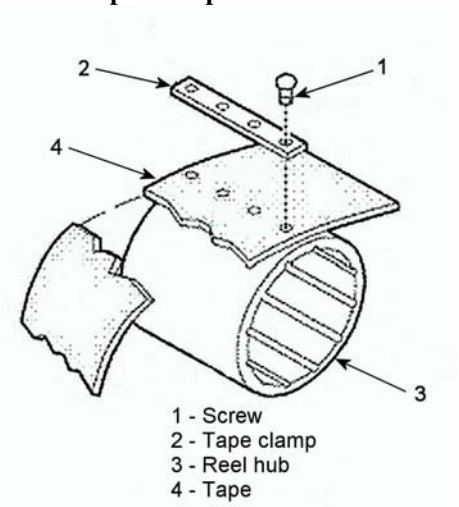
***NOTE*:** Determine if system is configured for a 990- or 1200-foot run-out. Even though tape storage reels are 66-inches in diameter and capable of a 1200-foot run-out, the system configuration may still be set-up for a 990-foot run-out. Pull tapes 7-1/2 feet from the reel and measure tape stack height to ensure the measurement is less than the maximum allowable (**Figure 1.15**). Avoid measuring tape stack height at the hump caused by the reel-hub tape clamp that attaches the tape to the reel (**Figure 1.16**). Install new tapes if maximum allowable measurement is exceeded.

WARNING

Following the MAAS installation, tape stack height measurements must be within the requirements for the runout of the system chosen. Maximum allowable tape stack-height measurements are found in Table 5-5 in both T.O. 35E8-2-5-1 for a 1200’ runout and T.O. 35E8-2-10-1 for a 990-foot runout.

Figure 1.15. Measuring Tape Stack Height.

Figure 1.16. Reel Hub Tape Clamp.



1.4.5. Aborted Takeoffs. A MAAS may be located at the end of a runway, and may be required to catch an aircraft aborting its takeoff. This *abort-end* MAAS may be required to catch an aircraft traveling at high speeds and mission takeoff weights. If this is a possibility, configure the MAAS to arrest heavyweight fighter aircraft in accordance with Table 8-1 in T.O. 35E8-2-

10-1. Also, ensure there is an adequate run-out zone for an abort-end engagement.

1.4.6. Clear Space. The centerline point of the aircraft run-out zone, **Point-D,** will be on the paved surface (**Figure 1.17**). For bidirectional operations, there are two run-out zone centerline points, **D1** and **D2** (**Figure 1.18**). An additional 60-foot of clear space pavement must follow beyond Point-D to allow the aircraft to make a 180° turn. The clear space will also provide enough room for emergency and tow vehicles to approach a disabled aircraft.

Figure 1.17. Aircraft Run-Out Zone—Unidirectional Operation.

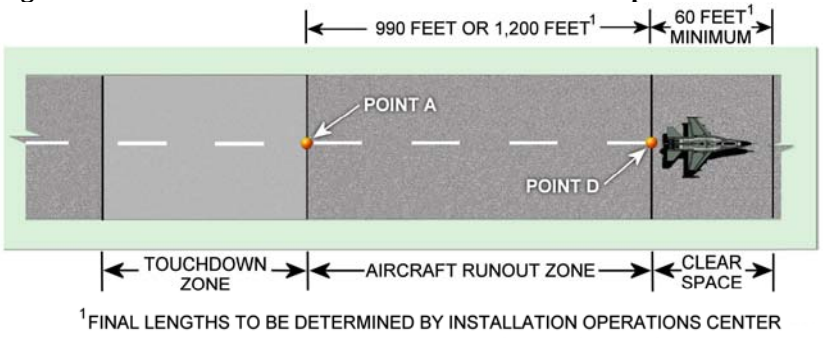
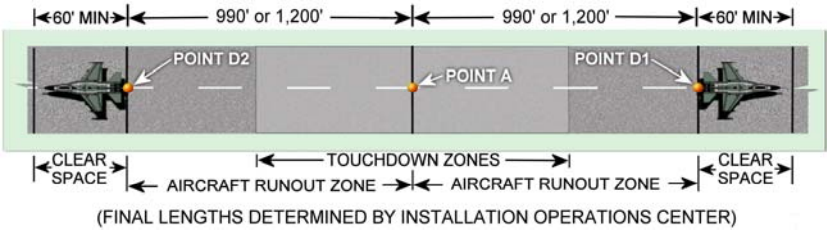


Figure 1.18. Aircraft Run-Out Zone—Bidirectional Operation.



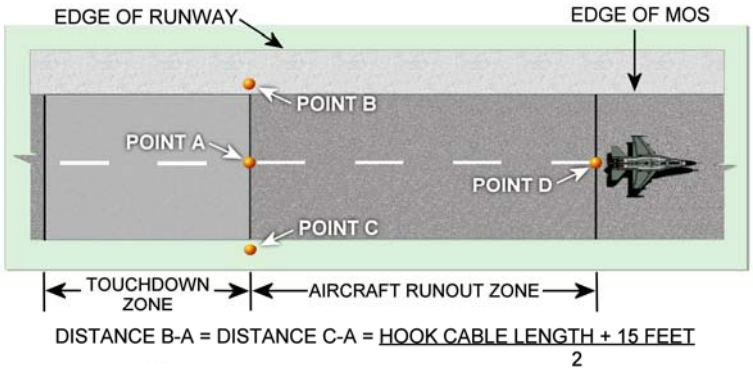
1.4.7. Siting Trailer Locations. The distance from **Point-A** on the MOS centerline to the leading edge of the trailer exit sheave is the cable length plus 15 feet (7.5 feet of exposed tape on both sides of the MOS), divided by 2 as shown in the formula below and in **Figure 1.19**. Align Points-B and -C

with Point-A so that the resulting line is perpendicular to the MOS center-line**.**

$$\text{Distance } \mathbf{B} \text{ to } \mathbf{A} = \frac{\text{cable length} + 15 \text{ ft}}{2} = \text{Distance } \mathbf{C} \text{ to } \mathbf{A}$$

***NOTE*:** The 15-foot used in the formula above is for ideal conditions and planning purposes; adjusting this number between 15 and 20 may be required to meet various MOS widths.

Figure 1.19. Establishing MAAS Set Points-B and -C.



1.4.7.1. Adverse Cable Dynamics. When siting the trailer locations, avoid conditions that may cause adverse cable dynamics, which occurs when the aircraft's landing gear contacts the cable, causing the cable to rebound and flex. Operational testing has shown that the length of the arresting cable in relation to the distance between runway edge sheaves is the critical factor in avoiding tail-hook skip caused by adverse cable dynamics. To reduce the possibility of this condition, the length of the cable should make up 80 to 90% of the distance between the exit sheaves (ideally 90%). The tape length between the cable end and the edge sheave should be between 7.5 and 10 feet (for centering purposes) while still meeting the 80 to 90% criteria.

1.4.7.1.1. Use 7.5 to 10-feet limit of exposed tape and the 80 to 90% criteria as the planning factors when planning for, locating, and installing the MAAS and/or fairlead beams.

CAUTION

The length of the cable should never be less than 80% of the distance between the edge sheaves to prevent adverse cable dynamics.

1.4.7.1.2. Whenever there is time to preposition cable, order a cable of the correct size to meet the optimum length criteria. In addition to the 90- and 153-foot cable lengths that come with the MAAS, the following cable lengths in AF inventory can be ordered by adding the 3-digit length at the end of P/N 515053-XXX: 105', 115', 130', 165', 175', 180', 185', 190', 195', 205', 230', 240', 280', 290', 295', 303', 390', and 490'.

NOTE: Wide runways require the cam to be switched with one that is made for wide runways. Follow procedures in T.O. 35E8-2-5-1 when performing installations on wide runways.

1.4.7.2. Trailer Alignment. Align trailers by sight or use the string line method. Explanation of both methods follows:

1.4.7.2.1. Align by Sight (**Figure 1.19**):

1.4.7.2.1.1. An experienced team member stands at Point-A and visually sites a line between Points-B and -C that is perpendicular to the MOS centerline.

1.4.7.2.1.2. Team member at Point-A holds end of a measuring tape and directs alignment of Set Point-B at distance B to A.

1.4.7.2.1.3. Extend line B to A to the opposite edge of the MOS. At Point A, measure distance A to C to establish Set Point C.

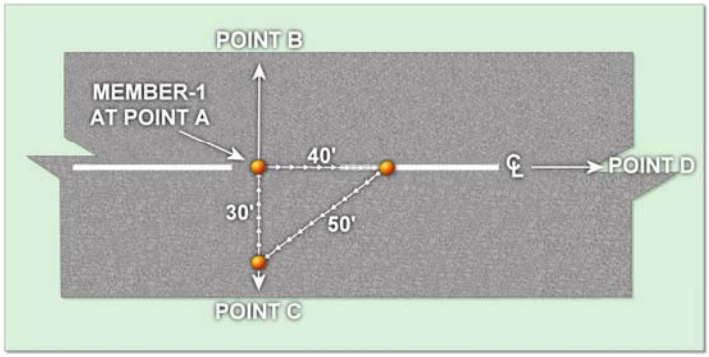
1.4.7.2.1.4. Check to ensure that Points-B, -A, and -C are in line and perpendicular to the MOS centerline.

1.4.7.2.2. Align by String Line Method. Refer to **Figure 1.20** for alignment with the string line method.

1.4.7.2.2.1. Mark a heavy string line at 40 feet, 90 feet, and 120 feet, or use a flexible measuring tape at least 120 feet of length.

1.4.7.2.2.2. Member-1 holds the end and 120-foot mark of the string at Point-A.

Figure 1.20. Locating Points-B & -C with String Line Method.



1.4.7.2.2.3. Member-2 holds the 40-foot mark on the MOS centerline in the direction of Point-D.

1.4.7.2.2.4. Member-3 holds the 90-foot mark on the line between Points-A and -B to form a triangle.

1.4.7.2.2.5. Member-1 remains at Point-A, Member-2 moves along the MOS centerline toward Point-D until the string line is taut between members-1 and -2. Member-3 then adjusts positions until the string becomes equally taut between all members.

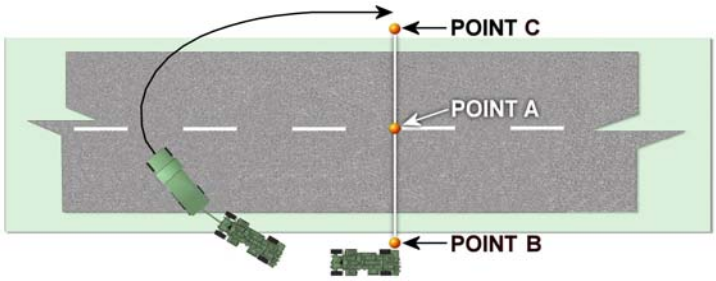
1.4.7.2.2.6. Mark the ground directly beneath the 90-foot mark on the string to establish a line perpendicular to the MAAS centerline.

1.4.7.2.2.7. Using a measuring tape, mark Set Point-B on this line at the predetermined distance from Point-**A** while staying aligned with Point-A and the 90-foot mark.

1.4.7.2.2.8. Extend a line from **Point-B through -A** to the predetermined distance between Points-**A** and **C;** then mark **Set Point-C;** ensure that **Points-B, -A,** and **-C** form a straight line.

1.5. Trailer Positioning. While approaching the runway, tow the MAAS units to the airfield in tandem with the centerline to the driver's right and parallel to the runway. This will position the runway edge sheaves so they face the runway. Drop one unit at **Point-B** such that the leading edge of the runway edge sheave (located behind the right rear wheel on the trailer) faces the runway centerline. Pull the other trailer around in an arch (**Figure 1.21**) and drop it at the opposite side of the runway, positioned such that the leading edge of the runway edge sheave is at **Point-C**. Both MAAS trailers should be parallel with the MOS centerline and positioned so that the tape connector and hook cable will fall on line from Point-B to Point-C. Ensure no part of the trailer or anchoring system extends into the tape sweep area. When in position, lower the swivel jack on the tow bar assembly, set the trailer parking brake, and disconnect the trailer from the prime mover.

Figure 1.21. Positioning the MAAS Trailers.



***NOTE*:** To avoid realignment after disconnecting and lowering, align the right-rear vertical reflector (on the taillight housing) over the set point. Set the parking brake and then lower the MAAS unit. This should keep the trailer within a couple of inches of the set point.

1.6. Lowering the Trailers. Before lowering trailers, remove the vinyl trailer cover, front storage box lid, and runway edge-sheave guard; store them when time permits. When installing the system on soil, remove the nine moil-points, bushings, and rear bracket of the stake storage rack. Store all items when time permits.

WARNING

Never attempt to raise or lower trailers on steep inclines. Instruct personnel to remain clear of trailer during raising/lowering operations.

CAUTION

Ensure area under trailer is flat and clear of foreign objects. Failure to remove the lid on the front storage box can cause damage to the 90-degree hydraulic elbow on the front hydraulic cylinder. Replace lid when installation is complete.

CAUTION

After trailer hydraulic repairs that caused fluid loss, cycle the system to remove air and adjust fluid levels prior to use to avoid damage or fluid overflow.

1.6.1. Connect the right side HPU hose to the trailer quick disconnect block behind the HPU. Ensure the quick disconnect fittings are clean before connecting. If the Wacker HPU and tools are still included with the system, use the separate 8-foot hoses on the ancillary connections of the HPU diverter valve assembly when raising and lowering the trailer.

WARNING

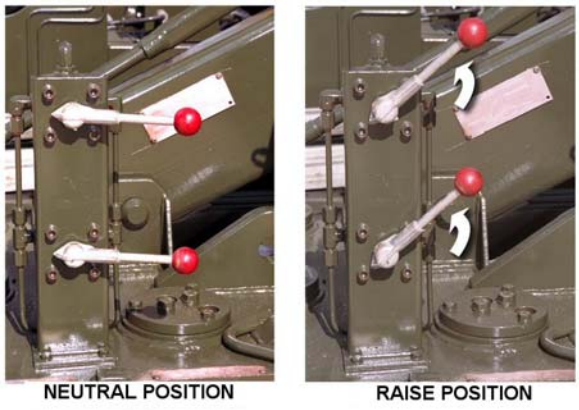
Wear hearing protection whenever operating the HPU or hearing loss may occur.

CAUTION

Use the same HPU to lower and raise the trailer to prevent transfer of hydraulic fluid between HPU reservoirs. If use of another HPU becomes necessary, adjust fluid levels prior to use to avoid damage or fluid overflow.

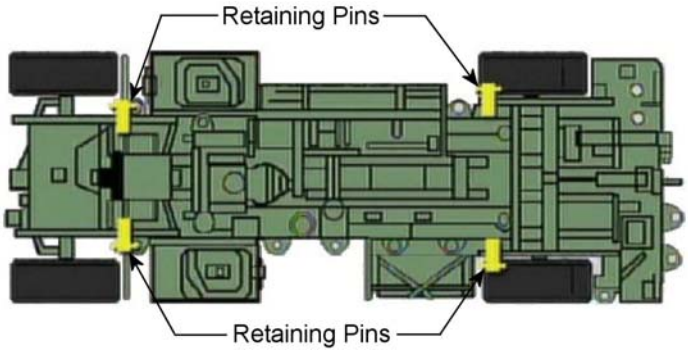
1.6.2. Lower the trailer by starting the HPU per the T.O., and raising the control valve handles to relieve pressure on the pins (**Figure 1.22**).

Figure 1.22. Hydraulic Control Levers Moved to "Raise" Position.



1.6.3. Remove the four axle-frame retaining pins. Two pins are located on the front of each axle support frame (**Figure 1.23**). Store the pins in the front storage box.

Figure 1.23. Axle-frame Retaining Pin Locations.



WARNING

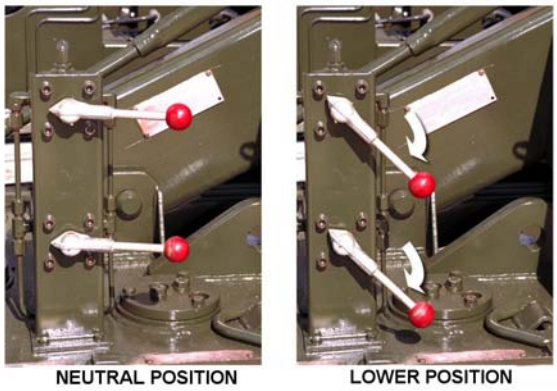
Keep feet and hands away from the axle frames and trailer bottom during raising and lowering operation. Ensure there is no equipment or other obstruction under the trailer.

CAUTION

Never place control valves in the "Lower Trailer" position with one pin installed. Never leave an axle frame with only one pin installed for an extended time. Damage to the axle support frame could result.

1.6.4. Place control valves in the "lower trailer" position (**Figure 1.24**). Lower trailer until the unit is solidly on the ground or pavement surface. If the trailer moves off its set point during the lowering operation, stop lowering before the unit contacts the surface. Raise the unit, replace the pins, release the brake, and reposition the trailer. Repeat the steps starting at paragraph 1.6.2 to lower the trailer.

Figure 1.24. Hydraulic Control Levers Moved to "Lower" Position.



***NOTE*:** When lowering the MAAS for installation **on level pavement** and the trailer moves off the set point, it may be possible to stop the trailer prior to it contacting the ground, and then repositioning it by hand. Do this only on level ground.

1.6.5. When axles are in the fully raised position, return control valves to their neutral position and shut down the HPU.

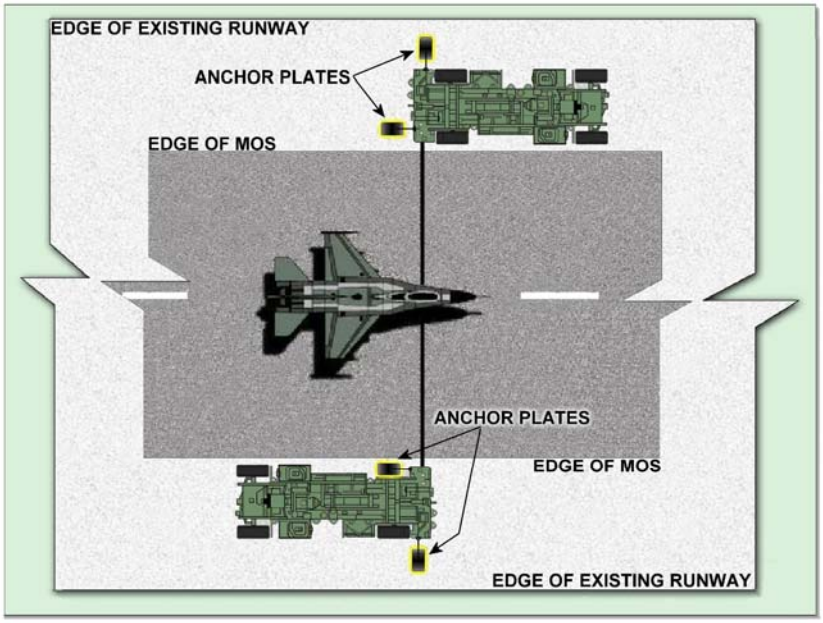
1.6.6. After lowering trailers, remove the tape connector from its stored location.

1.7. Unidirectional Concrete Installation (to include 1-inch or less asphalt overlay). Accomplish the concrete installation by connecting two anchor plates to the trailers using turnbuckles and then attaching the plates to the runway (**Figure 1.25**). This installation method can support heavier weight fighter aircraft operations.

***NOTE*:** The right and left side of the runway is based on the pilot's left and right when on the centerline and looking in the direction of aircraft travel.

1.7.1. With the trailers positioned and lowered, remove the required installation hardware and tools stored on each trailer (**Table 1.3**).

Figure 1.25. Concrete Installation—Unidirectional Operation.



See Para 1.2.1 for required setback distance

Table 1.3. Unidirectional Concrete Installation Hardware and Tools.

Description	*Quantity*
Hardware	
Anchor Plate	2
Taper Bolt	12
Washer, Flat	12
Nut	20
Turnbuckle	2
*Triple Turnbuckle Fitting	1

Table 1.3. cont. on next page

Tools	
3/4” Drive Ratchet	2
Extension, 4” Long	2
Socket 1-1/2 x ¾ Drive	2
Drill Bit, TE-60	4
Hydraulic Hammer Drill	2
Gauge, Taper Bolt	2
Tape Measure, 100’	1
Adjustable Wrench, 20”	1
Hammer, 4 lb.	1
Round Tube, 1-1/2 OD x 24”	1
NOTES: Hardware quantities shown are for installation of one MAAS trailer unit, and supplied with each unit. *Triple Turnbuckle Fittings installed on anchor bracket located near right rear tire of right trailer to prevent interference with the wheel brake hub during drilling procedures.	

WARNING

Wear appropriate personal protective equipment such as hearing and eye protection, work gloves, and safety toe boots whenever performing installation procedures or serious injury may occur.

1.7.2. The installation procedure is different for the MAAS trailer located on the right side of the runway. Due to the location of the trailer’s right side anchor point, remove the right rear tire prior to installing the anchor plate (**Figure 1.26**). After wheel removal, rethread the lug nuts on the wheel studs and store the wheel out of the way on the side of the trailer away from the runway.

WARNING

At least two people should work together when handling the 410-pound trailer wheel.

Figure 1.26. Anchor Connection at Right Rear Wheel.

1.7.3. Install the drill bit in the hydraulic hammer drill.

1.7.4. Connect the hydraulic hammer drill to the 50-ft hoses attached to the hydraulic power unit. Be sure to clean fittings before connecting.

1.7.5. Adjust the length of the two turnbuckles to approximately 39-inches; measured from the centers of the clevis pins (**Figure 1.27**).

Figure 1.27. Distance Measured Between Turnbuckle Clevis Pins.

1.7.6. Attach the locknut end of the turnbuckle to the trailer connection point. The locknut end of the turnbuckle is always installed toward the trailer (**Figure 1.28, 1.29, and 1.30**).

Figure 1.28. Right Rear Anchor Point—Right MAAS Trailer.

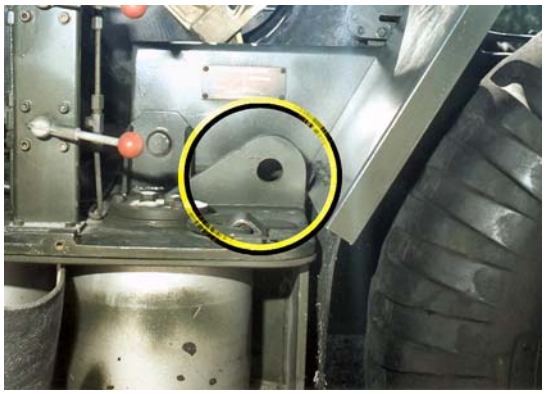


Figure 1.29. Left Rear Anchor Point—Both MAAS Trailers.

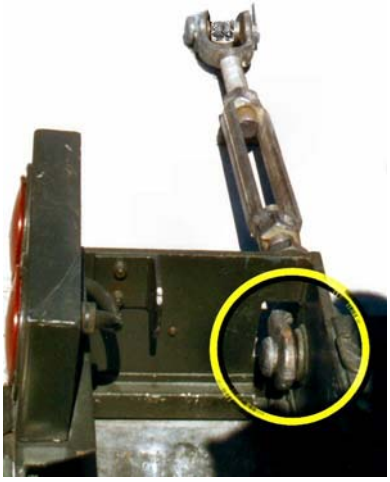
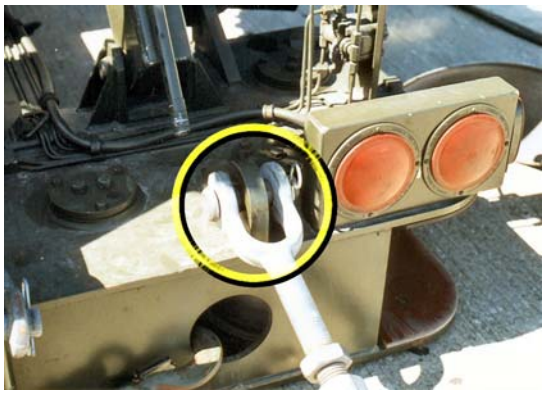
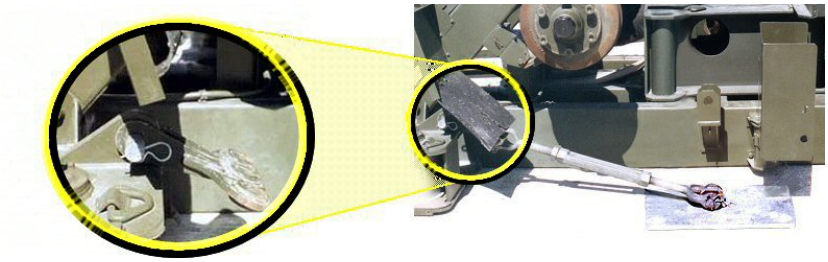


Figure 1.30. Right Rear Anchor Point—Left MAAS Trailer.



NOTE: If necessary, install a triple turnbuckle fitting on the anchor bracket located near the right rear tire of the trailer on the right side of the runway. This will prevent interference with the wheel brake hub during the drilling process (**Figure 1.31**).

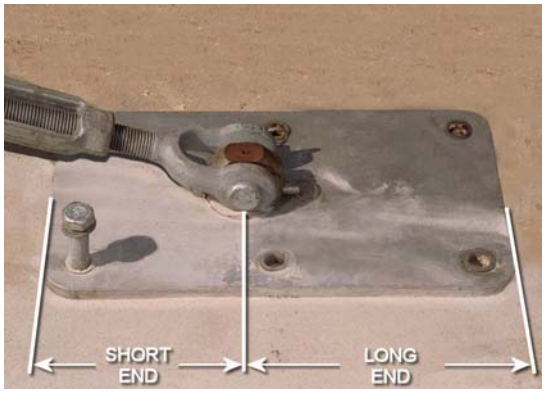
Figure 1.31. Right Rear Anchor Point w/Triple Turnbuckle Fitting.



1.7.7. Attach the other end of the turnbuckles to an anchor plate and align the plate so that it is perpendicular to the body of the trailer (**Figure 1.32**). The turnbuckle connection point on the anchor plate is closer to one end of the plate. The **short end** is always located toward the anchored equipment (**Figure 1.33**).

Figure 1.32. Plate Alignment (Pretension Anchor Point—Left Rear).

Figure 1.33. Partially Installed Anchor Plate.



WARNING

Use proper personal protective equipment such as hearing and eye protection, work gloves and safety toe boots when operating the HPU and hydraulic power equipment or serious bodily injury may occur.

1.7.8. Use the anchor plate as a template to drill six 1-inch diameter holes to a depth of 6-1/2 inches. Maintain plate position during the drilling process by inserting approximately half of a taper bolt, with washer and nut, into each completed hole. This will also prevent holes from filling with concrete dust during the drilling process.

1.7.9. Adjust the taper nut on the bolt such that inserting beyond half the bolt's length requires tapping with the 4-pound hammer. Seat six taper bolts and nuts using the hammer and taper bolt gauge to obtain the required 3/8-inch clearance between bolt heads and anchor plate. Then, tighten the bolts with the ratchet and socket provided in the tool kit.

CAUTION

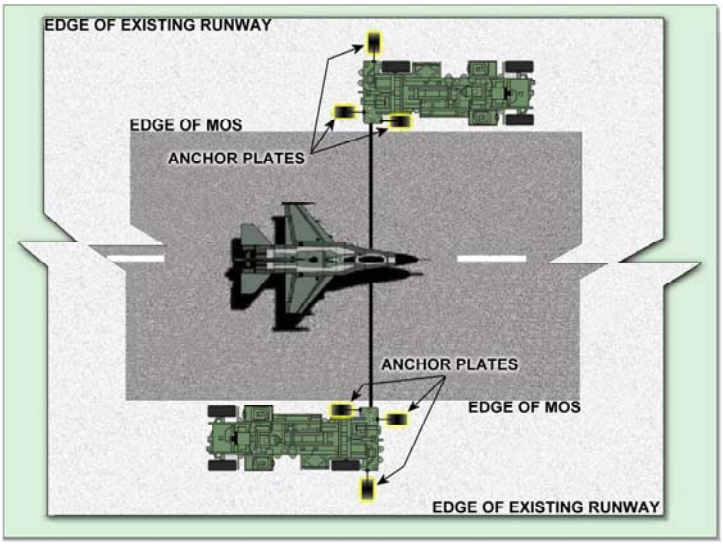
Install six anchor bolts to provide the proper safety margin for heavy weight aircraft. Should problems occur during an emergency installation (i.e., drill encounters unexpected re-bar) a minimum of four installed bolts will meet 40,000-pound arrestment loads at 150 knots. When time permits, upgrade to six bolts per anchor plate.

1.7.10. Tighten the turnbuckles to remove any slack, but do not over-tighten causing the trailer to move. Then, tighten the locknuts on the turnbuckles to prevent them from loosening.

1.7.11. Repeat these steps for the trailer on the opposite side of the runway. After the installation is complete, ready the MAAS for use following instructions in paragraph 1.16.

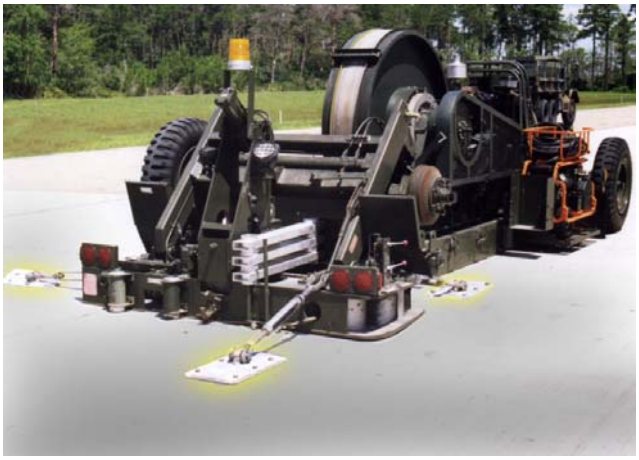
1.8. Bidirectional Concrete Installation. Accomplish bidirectional installation in same manner as described in the unidirectional configuration in paragraph 1.7. The difference is removing the runway side wheel on both trailers and adding an additional anchor plate for each trailer (**Figure 1.34**). This installation method can also support heavier weight fighter aircraft operations. Install three plates following normal installation procedures described in paragraphs 1.7.3 thru 1.7.10. Install both trailers using all three anchor point locations identified in **Figure 1.35**. After installing all three plates and tightening the turnbuckles, remember to tighten the locknuts on each turnbuckle. Repeat this process for the trailer on the opposite side of the runway. After the installation is complete, ready the MAAS for use by following instructions in paragraph 1.16.

Figure 1.34. Anchor Plate Locations—Bidirectional.



See Para 1.2.1 for required setback distance

Figure 1.35. Bidirectional Concrete Installation.

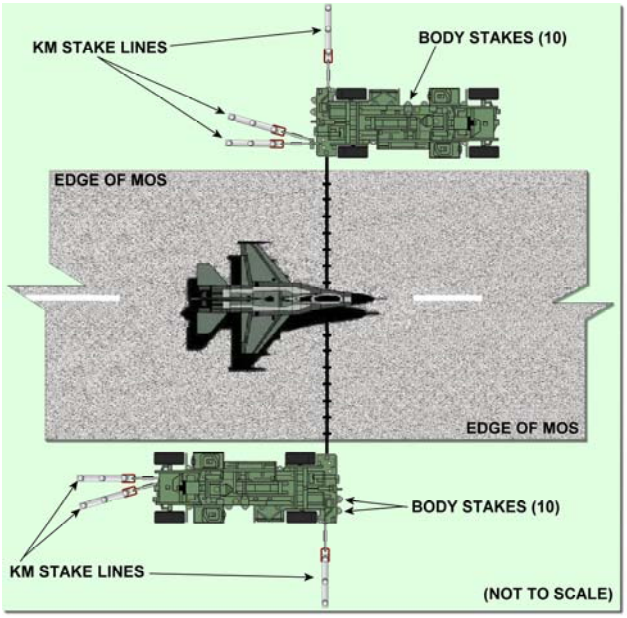


1.9. Unidirectional Soil Installation. Accomplish the soil installation by installing 66-inch body stakes and a KM-anchoring system (**Figure 1.36**). The anchoring configuration uses body stakes at 10 trailer stake pockets and three KM stake lines, with three stakes each, for a total of 19 stakes per trailer. Drive stakes into the soil with a hydraulic breaker or Stanley stake driver tool, which are powered by a hydraulic power unit (HPU).

NOTE: When the system has received the ETL 98-10 upgrade kit, it will have the Stanley stake driver, which does not require the drive shank and stake driver. Throughout the following stake installation instructions, the Stanley stake driver may be used in lieu of the hydraulic breaker with drive shank and stake driver.

1.9.1. With trailers positioned and lowered, remove the required installation tools and hardware stored on each unit (**Table 1.4**). If using the hydraulic breaker in lieu of the Stanley stake driver tool, remove work stands stored on each unit. Removable work stand legs are stored in the front storage box.

Figure 1.36. MAAS on Soil—Unidirectional Installation.



See Para 1.2.1 for required setback distance

Table 1.4. Unidirectional Soil Installation Hardware and Tools.

Description	*Quantity*
Hardware	
Stake	19
Spacer, Stake	6
Guide, Stake	3
Spacer	6
Turnbuckle	3
Triple Turnbuckle Fitting	1
Master Link	3

Table 1.4. cont. on next page

Tools	
Hydraulic Breaker	2
Stake Driver 3-1/2	2
Driver Shank 1-1/4 Hex	2
Tape Measure, 100’	1
Adjustable Wrench, 20”	1
Stanley Stake Driver (in lieu of breaker, stake driver, & driver shank)	2
NOTE: Hardware quantities shown are for installation of one MAAS trailer, and supplied with each trailer.	

WARNING

Wear hearing and eye protection, work gloves and safety toe boots when operating the HPU and hydraulic power equipment or serious bodily injury may occur.

1.9.2. Install the 1-1/4 inch hex-drive shank and the 3-1/2 inch stake driver on each hydraulic breaker.

1.9.3. Connect the hydraulic breakers to the HPU hoses. Ensure the quick disconnect fittings are clean before connecting.

1.9.4. Start the HPU and lower rear wheels to the ground to facilitate installation of body stakes around the wheel areas.

CAUTION

If work stands are used, a third person steadies the stand and operator during use of the hydraulic breaker.

***NOTE*:** Proper stake orientation will facilitate removal (**Figure 1.37**).

Figure 1.37. Proper Body Stake Orientation.

1.9.5. Insert the stakes through the 10 stake pockets located on the perimeter of the trailer (**Figure 1.38**). Drive the stakes until the painted portion reaches ground level (**Figure 1.39**).

NOTE: The 66-inch long stakes are painted green on the top 18 inches of the stake to indicate the recommended driving depth of 48 inches. Drive the stakes until the painted surface contacts the ground. If the stakes are not painted, attempt to drive the stakes 48 inches, but no less than 36-inches. If a stake hits an obstruction and cannot be driven to the minimum 36-inch depth after two minutes, move on to the next stake pocket location or relocate the stake line to allow for proper stake installation. When time permits, drive all stakes to the recommended depth.

Figure 1.38. Trailer Body Stake Locations.

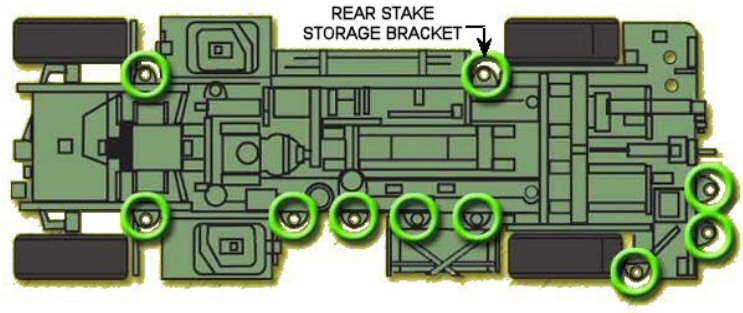


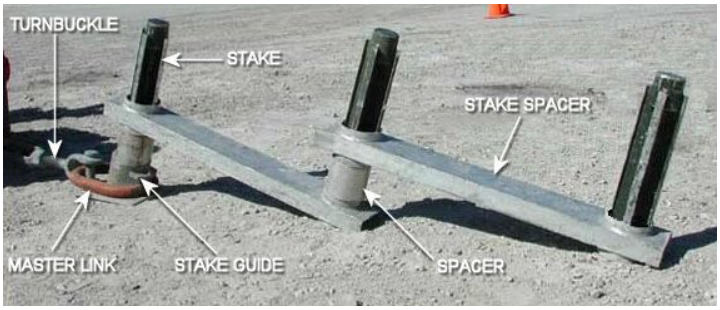
Figure 1.39. Typical Body Stake Installation.

NOTE: In an emergency and time is critical**,** install at least four body stakes (two per side nearest each corner) to full depth and nine stakes in the KM stake lines to a minimum depth of 36 inches. This configuration is limited to a 40K-pound aircraft engaging at 150 knots. After the emergency, install remaining stakes and drive to full depth.

1.9.6. After installation of the body stakes, return the axle support frame to its fully raised position.

1.9.7. Install the remaining nine stakes in the KM anchoring configuration as shown in **Figure 1.40**. Each stake line consists of one turnbuckle, one master link, one stake guide, three stakes, two spacers, and two stake spacers. The following steps detail the stake line installation.

Figure 1.40. 3-Stake KM Stake Line.



1.9.8. Stake lines are located at two anchoring locations on each trailer (**Figure 1.41, 1.42**, and **1.43**). Locations are dependent upon landing direction of the aircraft.

Figure 1.41. Left Rear Anchor Point—Left and Right Trailers.

Figure 1.42. Right Rear Anchor Point—Left MAAS Trailer.

Figure 1.43. Right Front Anchor Point—Right MAAS Trailer.

1.9.9. Adjust the length of the turnbuckles to approximately 36 inches measured between the centers of the clevis pins (**Figure 1.27**).

1.9.10. Attach the triple turnbuckle fitting to appropriate trailer body anchor point (**Figure 1.44** and **1.45**).

Figure 1.44 Triple-Turnbuckle Fitting Installed on Left Trailer.

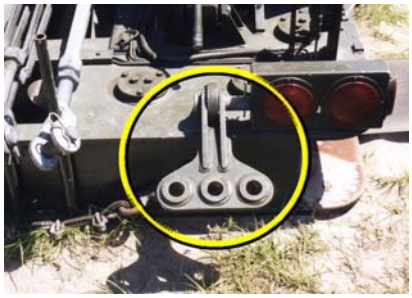


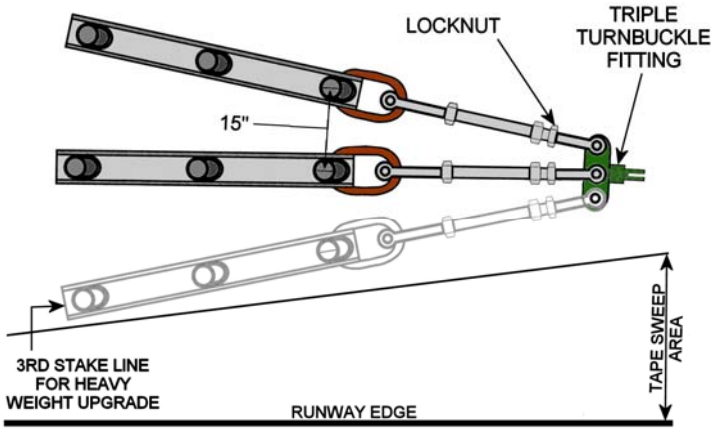
Figure 1.45 Triple-Turnbuckle Fitting Installed on Right Trailer.

1.9.11. Attach turnbuckles to the triple turnbuckle fitting and the pretension anchor point by securing the clevis pin with the hitch pin clip.

***NOTE*:** Attach the first turnbuckle to the center hole of the triple-turnbuckle fitting, and parallel to the centerline. Leave enough room towards the centerline to install a stake line, using the hole closest to the runway, without interfering with the tape sweep area in case the installation is upgraded for heavy weight aircraft later. The second turnbuckle is attached to the furthest position from the runway centerline of the triple-turnbuckle fitting (**Figure**

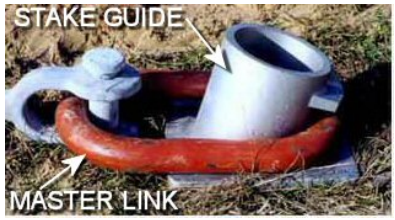
1.46). The KM stake lines on the triple-turnbuckle fitting are spaced at approximately 15 inches between the centers of the stake guides. The locknut end of the turnbuckle is always toward the trailer.

Figure 1.46. Triple-Turnbuckle Fitting with Two KM Stake Lines.



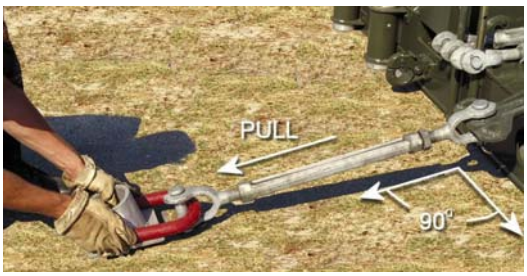
1.9.12. Install the master link around the stake guide; be sure the master link is under the retaining plate of the stake guide. Attach the free end of the master link to the turnbuckle (**Figure 1.47**). Always insert clevis pin from the top when attaching turnbuckles to the triple turnbuckle fittings and master links as in **Figure 1.47**. This will help ensure the clevis pins remain in place if the hitch pin clip falls out.

Figure 1.47. Master Link and Stake Guide.



1.9.13. Pull the stake guide and turnbuckle tight to remove slack and locate the first stake (**Figure 1.48**).

Figure 1.48. Removing Slack and Locating First Stake of Stake Line.



1.9.14. Place a stake through the stake guide and orient the stake such that the stake puller can grasp it during removal operations (**Figure 1.49**). The Stanley puller requires the stakes to have a "+" orientation and the legacy puller requires the stakes to have an "x" orientation. Drive the initial stake, and all subsequent stakes, at approximately a 15º angle away from the trailer (**Figure 1.50**). Attempt to drive the stakes through the stake guides and spacers with no metal-to-metal contact. This will keep the stakes angled at 15º; otherwise, removal of the stake spacers becomes extremely difficult. Damage to equipment and injury to personnel could occur while trying to force the components apart during tear down. Drive the stake until the 18-inch painted portion at the top reaches ground level.

Figure 1.49. Stake Orientation on Stake Spacer.

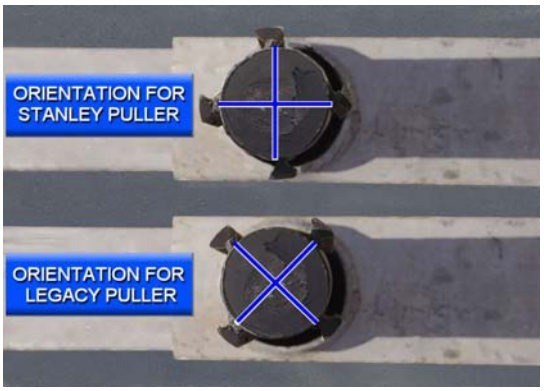


Figure 1.50. Driving Stake at 15º with Stanley Stake Driver.

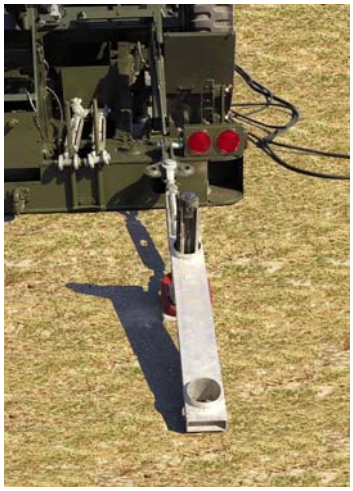
1.9.15. Install spacer over stake and rest it on stake guide (**Figure 1.51**).

Figure 1.51. Spacer (Ring) Installed over the Stake.

1.9.16. Install a stake spacer over the stake and rest it on the spacer (**Figure 1.52**). The centerline of the stake spacer must be in line with the turnbuckle (**Figure 1.53**). The free end of the stake spacer locates the next stake position.

Figure 1.52. Stake (Tie) Spacer Installed on Stake.

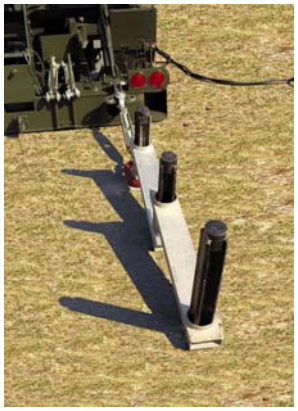
Figure 1.53. Straight Stake Centerline.



1.9.17. Insert the next stake through the end of the stake spacer. Drive the stake at approximately 15º away from the MAAS trailer. Do not drive it past the 18-inch painted portion at the top of the stake.

1.9.18. Repeat the above procedures for the third and last stake. Continue maintaining a straight centerline among the stake line components (**Figure 1.54**).

Figure 1.54. Complete Stake Line.



1.9.19. Tighten turnbuckle to remove slack in outrigger, but do not overtighten causing trailer to move. Tighten turnbuckle locknut.

1.9.20. Repeat steps in paragraphs 1.9.11. thru 1.9.20. for the remaining two KM stake lines.

1.9.21. After installing the stake lines, perform a final tightening check on all the turnbuckles and tighten the locknuts on each turnbuckle.

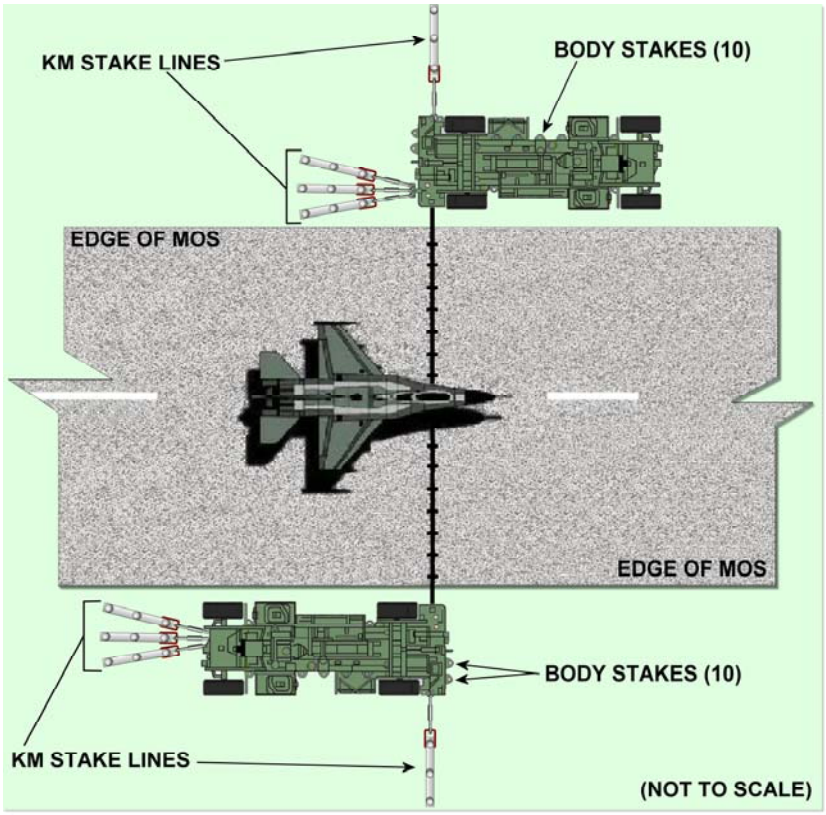
NOTE: There should be no gap between installation hardware after final tightening to ensure stability of the installation.

1.9.22. Repeat above actions for the trailer on opposite side of runway. After the installation is complete, ready the MAAS for use by following instructions in paragraph 1.16.

***NOTE*:** If installed for higher loads, such as for a heavyweight aircraft or for use as an abort end barrier, use an additional KM stake line totaling 22 stakes (**Figure 1.55**). Attach the additional stake line to the triple-turnbuckle fitting. Run the turnbuckle with the KM stake line closest to the runway centerline almost parallel to the edge of the runway. It may be angled toward the runway as long as the stake line does not extend into the tape sweep path (**Figure 1.56**). In order to **arrest heavier weight aircraft, increase the**

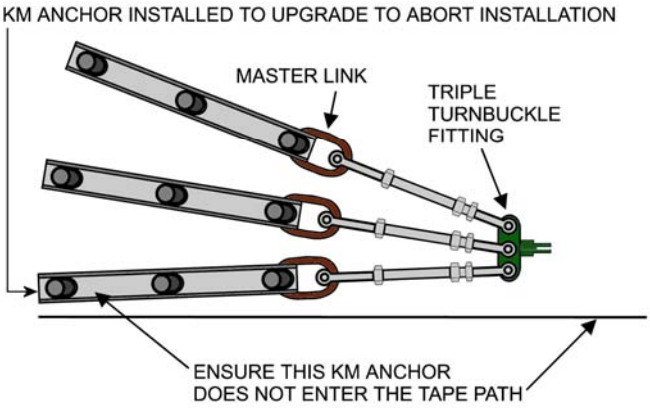
synchronization pressure and system run-out in accordance with Table 8-1 of T.O. 35E8-2-10-1, or Table 5-5 of T.O. 35E8-2-5-1. Use the heavy-weight configuration if supporting a mix of aircraft.

Figure 1.55. Heavyweight Unidirectional Soil Installation.



See Para 1.2.1 for required setback distance

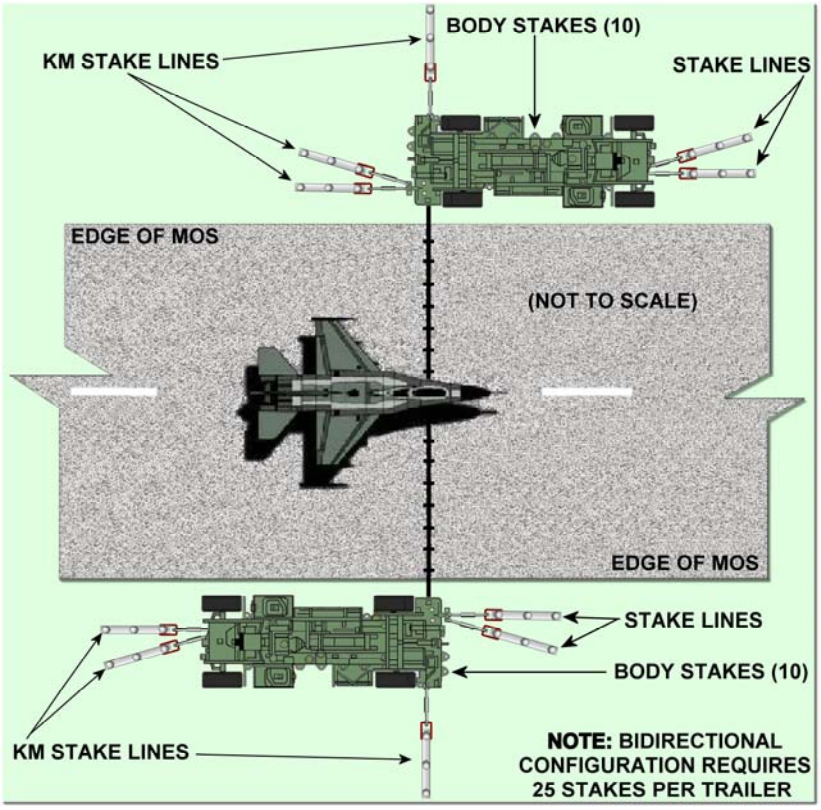
Figure 1.56. Triple-Turnbuckle Fitting with Three KM Stake Lines.



1.10. Bidirectional Soil Installation. Accomplish the bidirectional soil installation in the same manner as for the soil unidirectional configuration, and then add two additional KM stake lines on the front or rear anchor point of each trailer. This installation requires 25 stakes per trailer (**Figure 1.57**).

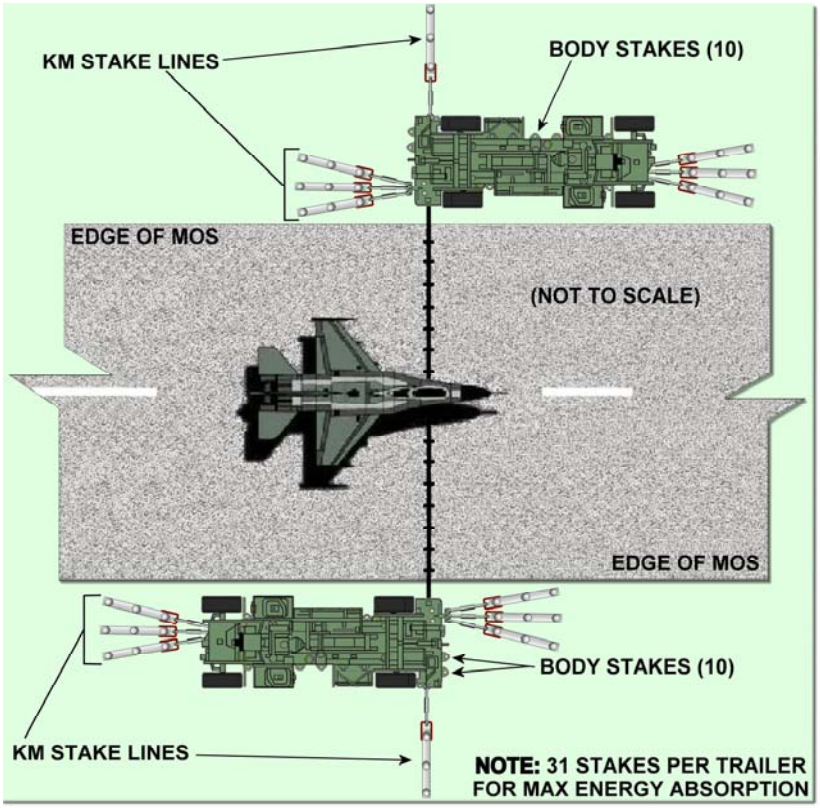
1.10.1. For a heavyweight setup, add an additional KM stake line to the triple turnbuckles at each end of the trailer. This configuration will use 31 stakes total (**Figure 1.58**). Do not forget to **increase the synchronization pressure and system run-out** in accordance with the references identified in the ***NOTE*** above. After the installation is complete, ready the MAAS for use by following instructions in paragraph 1.16.

Figure 1.57. MAAS on Soil—Bidirectional Operation.



See Para 1.2.1 for required setback distance

Figure 1.58. MAAS on Soil for Heavyweight, Bidirectional Operation.

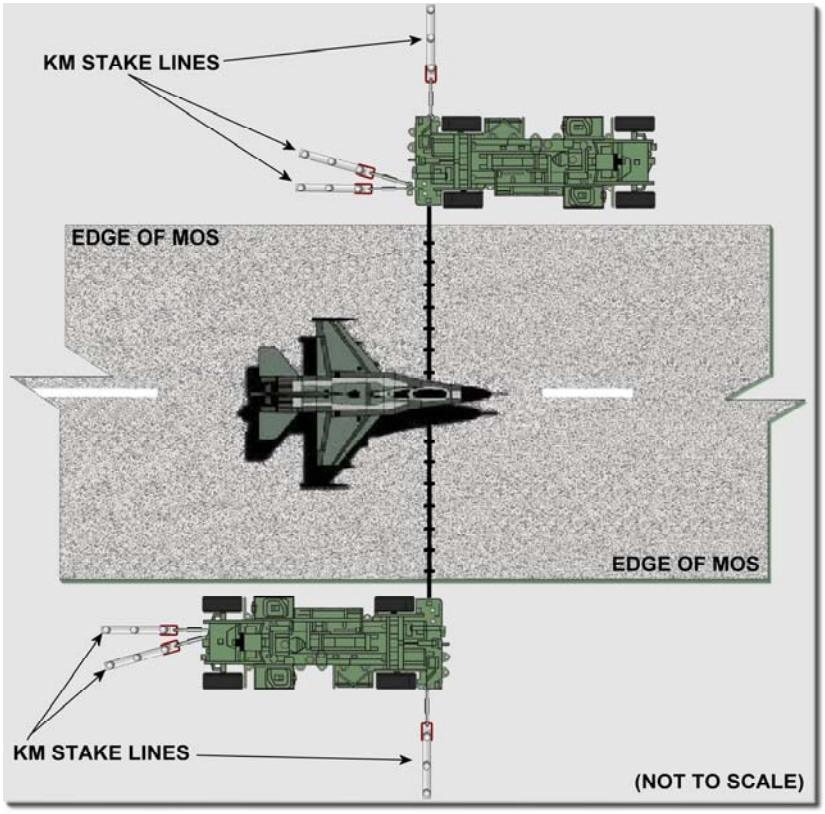


See Para 1.2.1 for required setback distance

1.11. Unidirectional Asphalt Over Soil Installation. Accomplish the installation on this type runway surface by installing the same KM anchoring system as used in the soil installation. The anchor mechanism uses three KM stake lines in a 3-stake system totaling nine stakes (**Figure 1.59**). Trailer body stakes are not required for the installation due to higher soil quality and compaction that is typically under asphalt paving. Besides not installing trailer body stakes, the only difference between this installation

and the soil installation is that asphalt is removed where stakes are driven into the ground. A digging chisel, used with the HPU and breaker, is required to remove the asphalt. Two digging chisels are contained in the installation tool kit to expedite installation. Mark the stake installation area on the asphalt while laying out the KM anchoring system. Then remove a section of the asphalt to allow for stake installation (**Figure 1.60**). Use the following procedures to remove asphalt at the stakes installation locations.

Figure 1.59. Unidirectional Asphalt Over Soil Installation.



See Para 1.2.1 for required setback distance

Figure 1.60. Asphalt Removal at Stake Location.

1.11.1. With trailers positioned and lowered, remove the required installation hardware and tools stored on each unit (**Table 1.5**). If the hydraulic breaker is used in lieu of the Stanley stake driver tool, remove work stands stored on each unit. Removable work stand legs are stored in the front storage box.

Table 1.5. Unidirectional Asphalt Over Soil Installation Hardware and Tools.

Description	*Quantity*
Hardware	
Stake	9
Spacer, Stake	6
Guide, Stake	3
Spacer	6
Turnbuckle	3
Triple Turnbuckle Fitting	1
Master Link	3

Table 1.5 continued on next page

Tools	
Hydraulic Breaker	2
Stake Driver 3-1/2	2
Driver Shank 1-1/4 Hex	2
Digging Chisel	2
Tape Measure, 100’	1
Adjustable Wrench, 20”	1
Stanley Stake Driver (in lieu of breaker, stake driver, & driver shank)	2
NOTE: Items and quantities shown are for installation of one MAAS trailer unit, and supplied with each unit.	

1.11.2. Attach the digging chisels to the hydraulic breaker units.

1.11.3. Connect hydraulic breakers to the 50-foot hoses attached to the HPUs. Ensure the quick disconnect fittings are clean before connecting.

1.11.4. After installing the turnbuckle, master link, and stake guide, pull tight to remove slack and mark the asphalt by tracing the inside of the stake guide with a marker or sharp object to mark the location of the first stake (**Figure 1.61**).

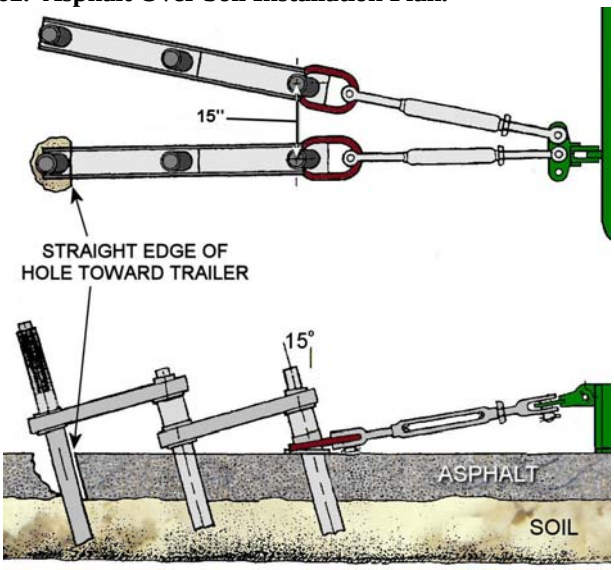
Figure 1.61. First Stake Location Marked on Asphalt.

WARNING

Use proper personal protective equipment such as hearing and eye protection, work gloves and safety toe boots when operating the HPU and hydraulic power equipment or serious bodily injury may occur.

1.11.5. Start the HPU and chisel out the marked asphalt using the digging chisels on the hydraulic breakers. Make sure the side of the hole closest to the trailer has a vertical straight edge angled at approximately 15º (**Figure 1.62**).

Figure 1.62. Asphalt Over Soil Installation Plan.

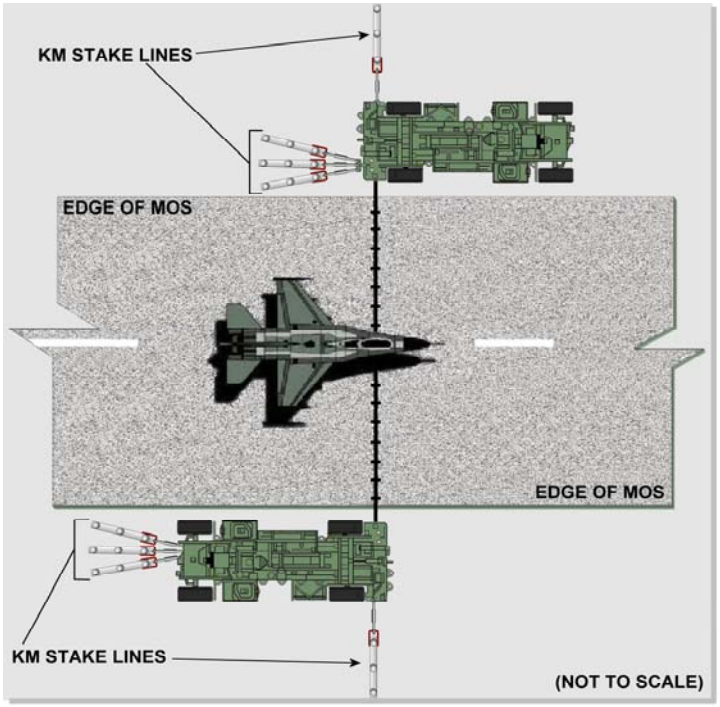


1.11.6. Do not use this method when the asphalt is greater than 12 inches deep. This method may not be effective when the depth of the asphalt is between 6 and 12 inches deep if the hole can not be readily chiseled to the di-

ameter of the stake (with or without weakening the strength of the base materials). If any of these two conditions exist, inform the Wing or Installation Operations Center that the MAAS installation location is unacceptable requiring a new location selection.

***NOTE*:** If the installation is for heavyweight aircraft or for use as an abort end barrier, use an additional stake line just as in the soil installation, totaling 12 stakes per trailer (**Figure 1.63**). In order to arrest **heavier weight aircraft,** do not forget to **increase the synchronization pressure and system run-out** in accordance with Table 8-1 of T.O. 35E8-2-10-1 or Table 5-5 of T.O. 35E8-2-5-1**.**

Figure 1.63. Heavyweight/Abort End Asphalt Over Soil Installation.



See Para 1.2.1 for required setback distance

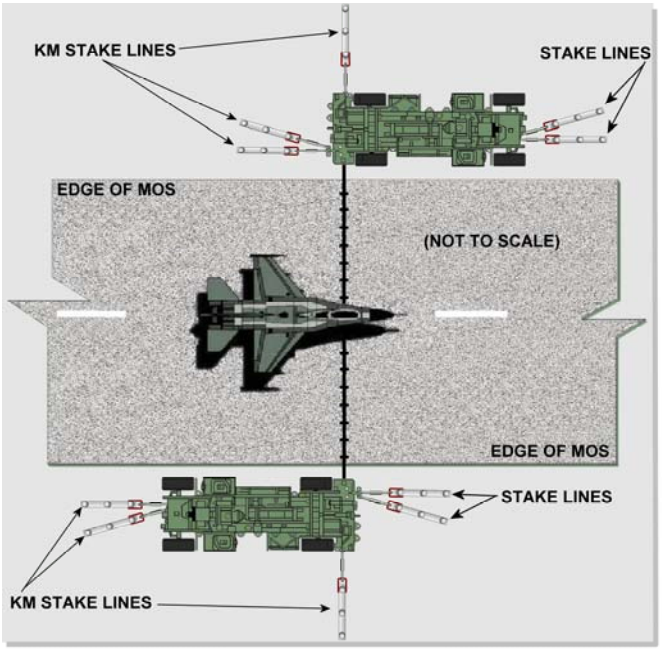
1.11.7. Install the stake lines per normal procedures.

1.11.8. Perform a final tightening check on all the turnbuckles, but do not tighten enough to cause the trailer to move. Tighten the locknuts on each turnbuckle.

1.11.9. Repeat the above actions for the MAAS on the other side of the runway. After the installation is complete, ready the MAAS for use by following instructions in paragraph 1.16.

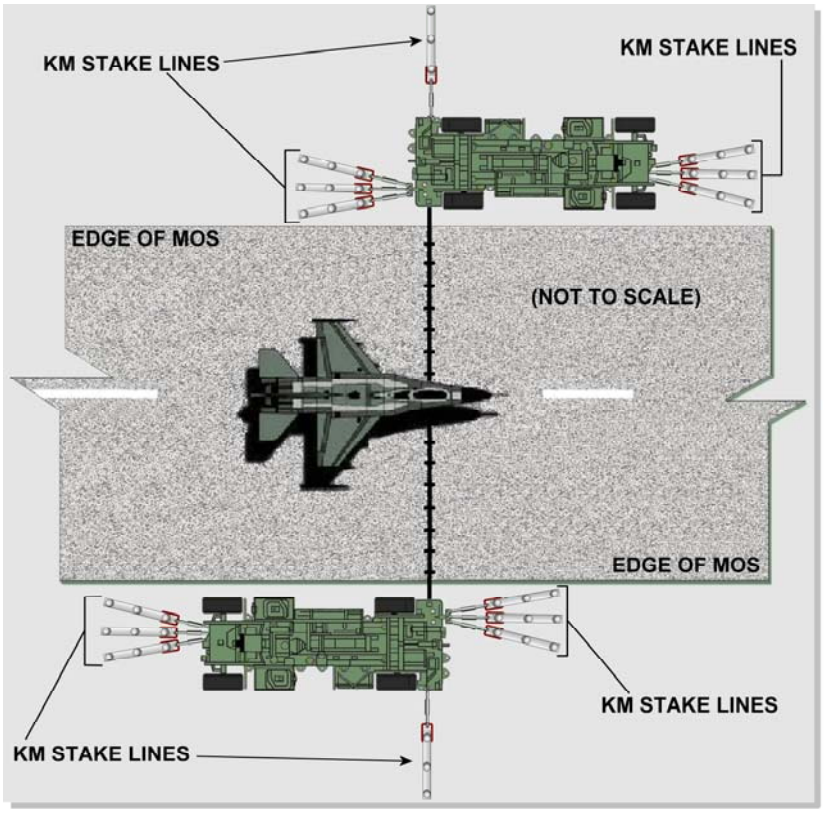
1.12. Bidirectional Asphalt Over Soil Installation. Accomplish the bidirectional asphalt over soil installation in the same manner as for the unidirectional configuration, and then add two additional KM stake lines on the third anchor point on the front or rear of each trailer. This installation requires 15 stakes total per trailer (**Figure 1.64**; see para. 1.2.1 for setback distance).

Figure 1.64. Bidirectional Asphalt Over Soil Installation.



1.12.1. For a heavyweight setup, add an additional KM stake line to the triple turnbuckles at each end of the trailer. This configuration will use 21 stakes total per trailer (**Figure 1.65**). In order to **arrest heavier weight aircraft,** do not forget to **increase the synchronization pressure and system run-out** in accordance with Table 8-1 of T.O. 35E8-2-10-1 or Table 5-5 of T.O. 35E8-2-5-1. After installation is complete, ready the MAAS for use by following instructions in paragraph 1.16.

Figure 1.65. Bidirectional Heavyweight Asphalt Over Soil Installation.



See Para 1.2.1 for required setback distance

1.13. Asphalt Over Concrete Installation. Accomplish installation on this type of runway surface by installing moil points through bushings (**Figure 1.66**) in the ten stake pockets on each trailer (**Figure 1.67**). Using the HPU and breaker, these moil points are driven through the asphalt and into the concrete base. Install both trailers identically regardless of aircraft direction of travel. Therefore, the installation is capable of **bidirectional engagements** (**Figure 1.68**). The following paragraph describes this installation.

Figure 1.66. Moil Point and Bushing.

Figure 1.67. Trailer Moil Point Locations.

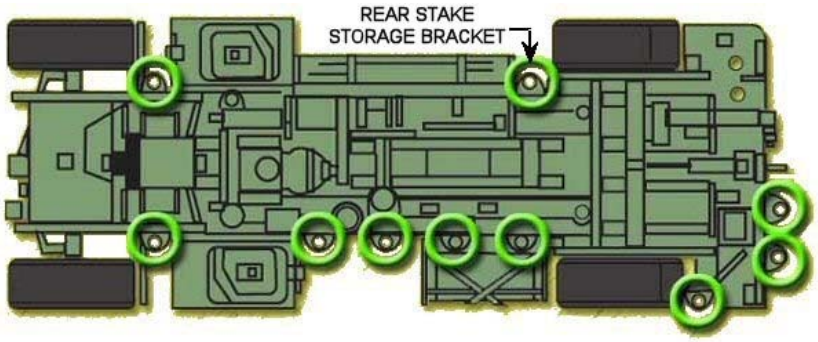
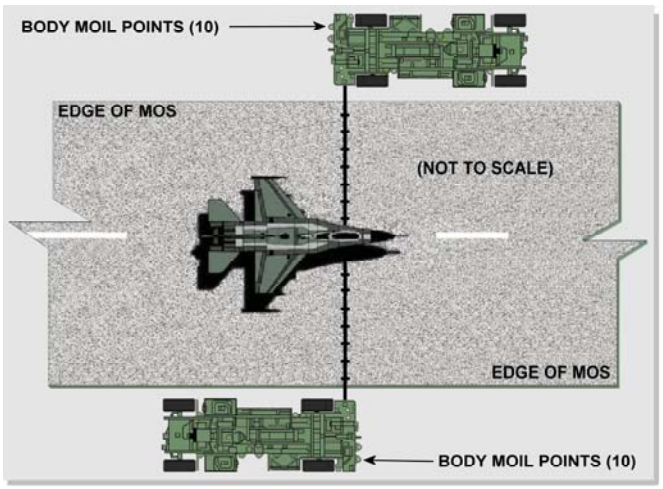


Figure 1.68. Asphalt Over Concrete Installation.



See Para 1.2.1 for required setback distance

CAUTION

Determine if asphalt layer is 6” or less in depth. Asphalt should not be brittle or have block cracking to the point that layers have failed. Asphalt greater than 6” in depth may prevent moil point from securely embedding into concrete.

NOTE: If asphalt overlay is 1-inch or less, use concrete installation configuration described in paragraph 1.7. Drill through overlay when installing taper bolts.

CAUTION

Load limit of moil points on a asphalt over concrete runway is a 40,000-pound aircraft at 150 knots.

1.13.1. With trailers positioned and lowered, remove required installation tools and hardware stored on each trailer (**Table 1.6**).

Table 1.6. Asphalt Over Concrete, Unidirectional Installation Hardware/Tools.

Description	*Quantity*
Hardware	
Moil Point	10
Bushing, Stake Pocket	10
Tools	
Hydraulic Breaker	2
NOTE: Items and quantities shown are for installation of one MAAS trailer unit, and supplied with each unit.	

1.13.2. Remove cruciform stakes and rear stake storage bracket (**Figure 1.67**).

1.13.3. Install a stake pocket bushing in the stake pocket where the bracket was removed.

WARNING

Use proper personal protective equipment such as hearing and eye protection, work gloves and safety toe boots when operating the HPU and hydraulic power equipment or serious bodily injury may occur.

1.13.4. Connect the hydraulic breakers to the 50-foot HPU hoses. Ensure the quick disconnect fittings are clean before connecting. Start the HPUs, per normal operating procedures.

1.13.5. Lower the rear wheels to the ground by positioning the rear raise/ lower control valve to the raise position (**Figure 1.22**).

1.13.6. Insert a moil point into the breaker and lock it into place.

1.13.7. Insert the moil point through the bushing in the stake pocket and drive the moil point through the asphalt and into the concrete (**Figure 1.69**). Stop driving when the bottom of the locking retaining spring of the breaker is just above the MAAS trailer body frame. When using the Stanley breaker, the bottom of the locking latch will just be touching the moil point bushing (**Figure 1.70**). This will provide the required clearance to allow removal of the moil points.

Figure 1.69. Moil Point Being Driven Through Asphalt.

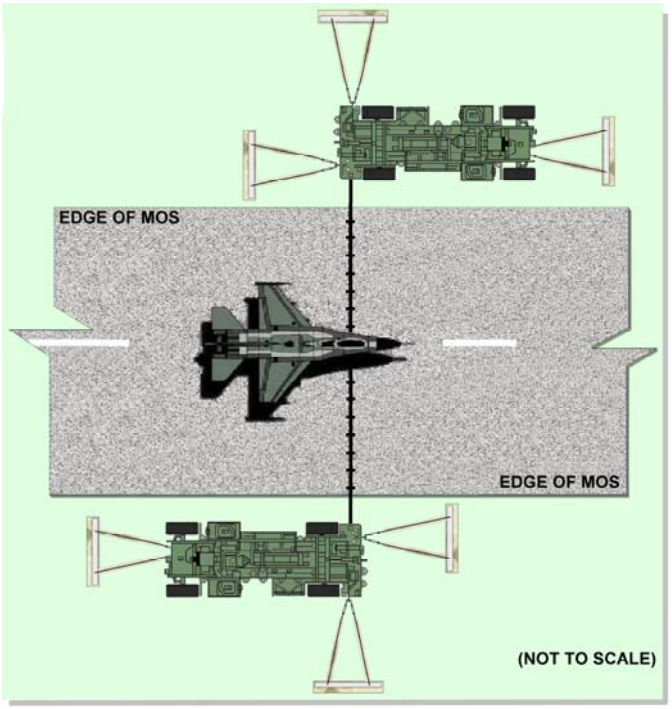
Figure 1.70. Stanley Breaker Stopping Point when Driving Moil Point.

1.13.8. Unlock the moil point from the breaker and repeat the above two steps for the nine remaining moil points.

1.13.9. After installing all 10 moil points, raise the axle support frame to its fully raised position, shut down the HPU, and store breakers and hose assemblies. Move to the trailer on the opposite side of the runway and repeat the above steps. After installation is complete, ready the MAAS for use by following instructions in paragraph 1.16.

1.14. Installation on Low Bearing Pressure Soil (CBR Less Than 7): Installation of the MAAS on a surface with a very low bearing pressure (**Figure 1.71**) is accomplished by installing three sets of deadman anchors and 10 body stakes. Deadman anchors are connected to the same three trailer anchor points that were utilized in the previous configurations.

Figure 1.71. MAAS with Deadman Anchors (Low CBR Soil).



See Para 1.2.1 for required setback distance

1.14.1. Anchoring locations are not dependent on aircraft approach direction. This installation can support bidirectional arrestments and heavier weight fighter aircraft.

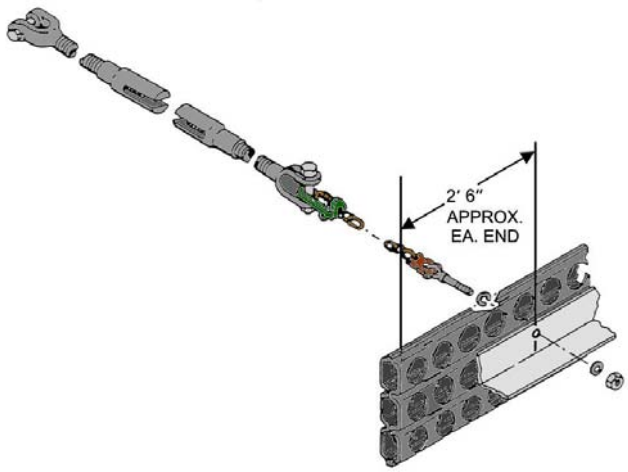
1.14.2. Additional team members are needed for digging, filling, and compacting trenches associated with installation of deadman anchors. This installation requires support of heavy equipment and operators.

1.14.3. Obtaining and fabricating metal deadman and backer plates will be required ahead of the installation. When planning a deployment to a location that has low bearing pressure soil, consider deadman chain assembly anchors early on in the process. **Table 1.7** lists items that make up the deadman anchors for one trailer. Obtain the materials and/or fabricate (**Figure 1.72**) prior to deployment when rapid installation is required. The installation steps outlined below do not detail the construction of the deadman anchors. See T.O. 35E8-2-5-1 for instruction on fabricating the dead-man anchor assemblies.

Table 1.7. Deadman Anchor Parts.

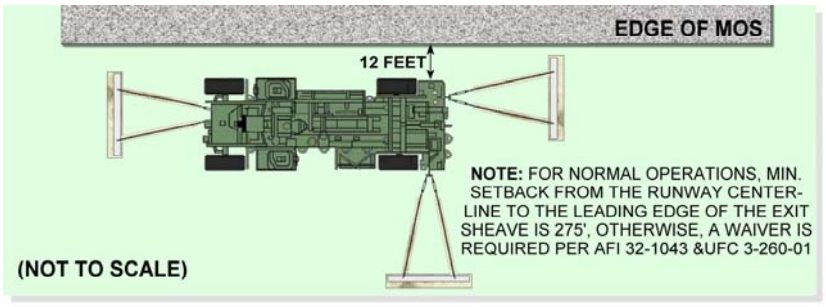
Description	*Quantity*
Chain Assembly Anchors	6 each
Triple-turnbuckle fittings	3 each
Turnbuckle Assembly	6 each
Backup angles, 6 inch x 6 inch x 3/8 inch by 2 foot	6 each
12 foot perforated steel planking (PSP) matting	6 each
or	
12 foot aluminum matting (AM2) matting	3 each
Trailer adapter fitting, complete	
Fitting	1 each
Pin	2 each
Hitch Pin Clip	2 each

Figure 1.72. Typical Fabrication of Chain and Deadman.



1.14.4. For an emergency expeditionary installation, minimum setback distance from the runway is 12 feet (**Figure 1.73**). This should allow a sufficient distance from the runway for excavation while protecting the runway base materials from being disturbed, thus weakening the pavement structure. Increase the distance if initial excavation shows a problem with soil instability near the runway. Follow the steps below to install the trailers with deadman anchors on low bearing pressure soils.

Figure 1.73. Setback Distance and Layout.



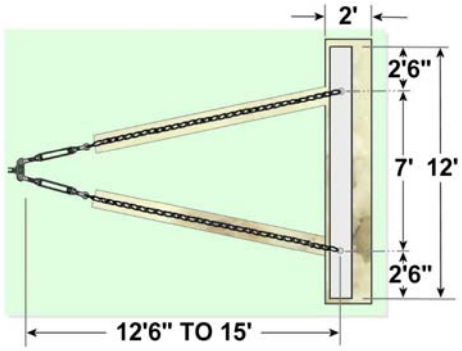
1.14.5. Position the trailers for the required runway setback and barrier hook cable location. Mark the locations where the three anchor points will fall at the right front, left rear, and right rear of the MAAS trailer anchor points. A backhoe, roller-compactor, compactor plates, shovels, and/or excavator could be used for the installation of the deadman anchors.

1.14.6. Verify the length of the deadman anchor chains as laid out to ensure that the exact dimensions are known. Anchor chains, triple-turnbuckle fitting, turnbuckles, and plate attachment hardware together should measure between 12-1/2 feet and 15 feet. Normally the component lengths should not exceed 15 feet.

***NOTE*:** Install turnbuckles with the locknut ends towards the trailer.

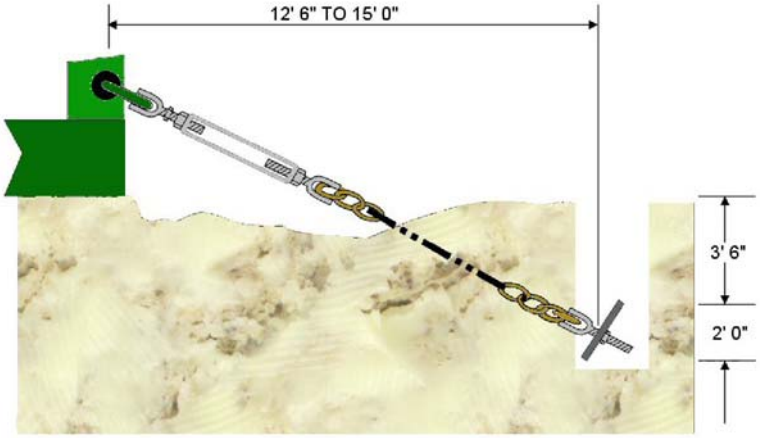
1.14.7. Lay out the trench locations based on the anchor positions (**Figure 1.74** and **1.75**). Dig all trenches to depth, starting with the chain trenches to keep cave in at the larger deadman trench to a minimum. Use the smallest backhoe bucket available, preferably a 12-inch wide bucket, for the chain trenches. A 24-inch wide bucket is adequate for the deadman trenches.

Figure 1.74. Typical Deadman, Chain, and Trench Layout—Plan View.



1.14.8. The load bearing face of the deadman trench should be undisturbed to provide a firm surface against which the deadman will bear. Should it be over-excavated, the new face should be compacted and shaped as shown in **Figure 1.75**. Ensure the deadman trench has a vertical front face and has at least 3 feet 6 inches of cover above the top of the deadman.

Figure 1.75. Deadman, Chain, & Trench Layout—Elevation View



1.14.9. Adjust the six turnbuckles so that there is approximately 39 inches between the centers of the clevis pins.

***NOTE*:** Install the trailer adapter fitting at the left rear anchor point on the MAAS trailer before attaching the triple-turnbuckle fitting.

WARNING

Use proper personal protective equipment such as hearing and eye protection, work gloves and safety toe boots when operating the HPU and hydraulic power equipment or serious bodily injury may occur.

1.14.10. With the trailer properly positioned at the set point, lower the trailer per previously described procedures.

1.14.11. Attach the triple-turnbuckle fittings to the trailer anchor points and attach the turnbuckles to the fittings.

1.14.12. Connect deadman anchors to the anchor chain assemblies and lower the deadman anchors into the trenches. Brace the dead-man in position so it is at 90° to the angle of the chain (**Figure 1.75**).

1.14.13. Fill deadman trench 6 inches over deadman and compact soil. Continue to fill deadman trench using 6-inch lifts and compact each lift**.**

1.14.14. Pretension anchors to stretch the chains out, but do not allow the trailer to move. Ensure that the chains do not rotate and possibly loosen the nuts on the anchor plates.

1.14.15. Repeat above process of filling and compacting anchor chain trenches up to the turnbuckles, and then compact and level the trenches.

1.14.16. With the trailer anchored, remove the required installation tools, hardware, and the work stands stored on the trailer. Remove the rear bracket of the stake storage rack and the nine moil-point bushings before lowering the trailer. Store the bushings in the equipment storage box on the side of the trailer.

***NOTE*:** When a MAAS has received the ETL 98-10 equipment upgrade, it will have the Stanley stake driver, which does not require the use of a drive shank and stake driver. When mention is made of using a hydraulic breaker, a Stanley stake driver may be used in its place.

1.14.17. Connect the 50-foot hydraulic hose to the right side HPU and the quick disconnect block. Ensure that the quick disconnect fittings are clean before connecting.

1.14.18. Lower the rear wheels to the ground to facilitate installation of the body stakes.

1.14.19. Install 1-1/4 inch hex drive-shank and 3-½ inch stake driver on each hydraulic breaker. Connect hydraulic breakers to 50-foot HPU hoses. Ensure quick disconnect fittings are clean before connecting.

WARNING

Use proper personal protective equipment such as hearing and eye protection, work gloves and safety toe boots when operating the HPU and hydraulic power equipment or serious bodily injury may occur.

1.14.20. Place ten stakes in the stake pockets (**Figure 1.38**) located along the perimeter of the trailer, properly orient them for later removal (**Figure 1.37**), and drive them into place with the breakers. Stop driving when the painted portion reaches ground level (**Figure 1.39**).

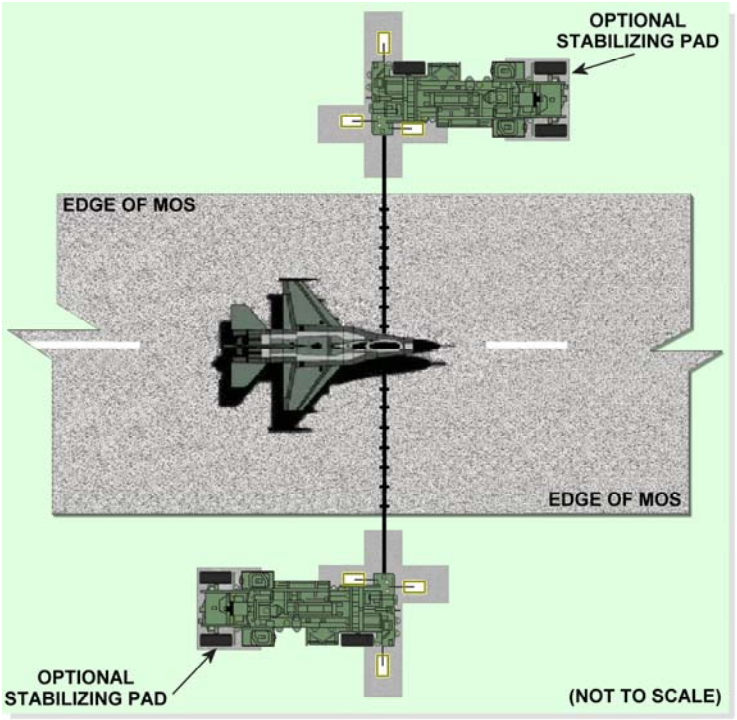
1.14.21. After installing the body stakes, return the axle support frame to the fully raised position.

1.14.22. Perform a final tightening check on all turnbuckles and tighten locknuts on each turnbuckle. Store all installation tools when complete.

1.14.23. Repeat the above actions for the MAAS on the opposite side of the runway. After the installation is complete, ready the MAAS for use by following instructions in paragraph 1.16.

1.15. Installation on Permafrost. Installation in arctic climates where permafrost conditions exist requires the construction of concrete cruciform foundations. This installation can also be used for installation on low bearing pressure soils. The foundations have sufficient mass, depth, and bearing surface to remain stable during freeze/thaw conditions and to withstand the forces of the aircraft engagement. This installation method can support heavier weight fighter aircraft operations and is capable of bidirectional operations. The adjacent surface area where the trailer will sit must be level to match the foundation height and must be capable of supporting the weight of the trailer. If installed on low CBR soil or during thaw cycles, support the front of the trailer with an addition concrete pad. Approximate dimensions are 7-foot by 9-foot, by 6-inches thick (**Figure 1.76**).

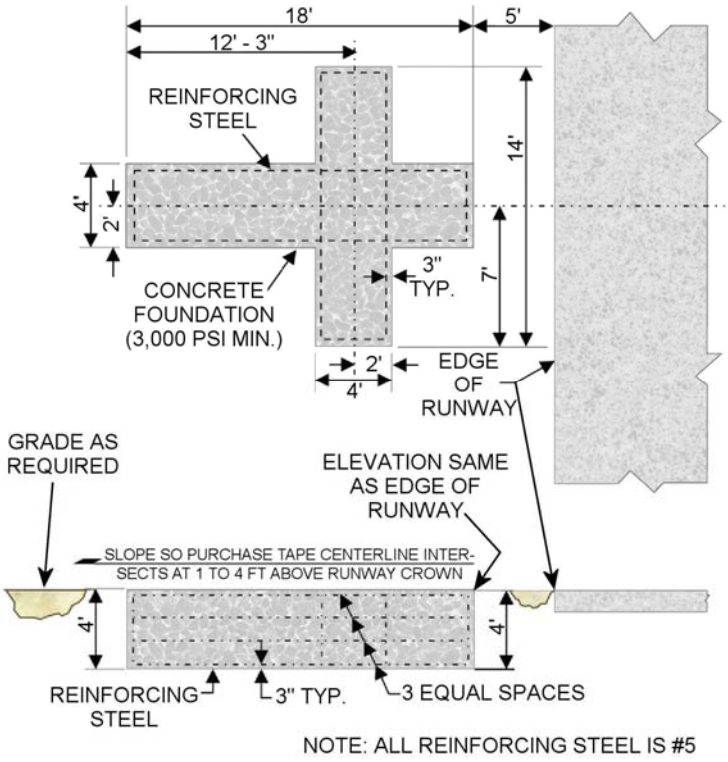
Figure 1.76. Cruciform (PCC) Platform Installation.



See Para 1.2.1 for required setback distance

1.15.1. The foundation system is reinforced concrete in a cruciform shape (**Figure 1.77**). When constructed as shown, the concrete foundation rebar should not interfere with the installation of anchor bolts. Locate and adjust the plate locations to keep the edge of the plates at least 4 inches from the edge of the cruciform platforms to avoid interference while drilling bolt-holes. Ensure the system is equipped with a sufficient quantity of concrete installation hardware. If not, order kits before the deployment. Install the system per bidirectional concrete installation steps in paragraph 1.8. After the installation is complete, ready the MAAS for use following instructions in paragraph 1.16.

Figure 1.77. Concrete Cruciform Foundation Details.



***NOTE*:** When resources are not a consideration, a 14' x 18' rectangle foundation may be installed in place of the cruciform foundation. Real world experience has proven that a rectangle pad is easier to form and pour, provides easier installation, and the trailer sits better on the rectangle pad.

1.16. Basic Steps for Readying the MAAS. Remove the hook cable from its storage reel and drag it across the runway during trailer installation.

***NOTE*:** If using prepositioned hook cables instead of the 90-foot or 153-foot hook cables supplied with the MAAS, bring the prepositioned cable to the site and prepare it for use (to include installing support discs).

1.16.1. Pull enough slack from the tape storage reel to allow attachment of the hook cable to the tape connectors. Obtain slack by pulling tape from the trailer using two or three individuals, or by using a vehicle. Ensure BAK-12 shuttle valve is in the OFF position for this operation.

1.16.2. Attach the ends of the hook cable to the tape connectors.

WARNING

Use proper hearing protection when operating the rewind engine or hearing loss may occur.

***NOTE*:** If not under combat or emergency conditions, check the integrity of the installation and stretch new tapes by proof loading the system IAW T.O. 35E8-2-10-1. In addition, conduct a certification engagement (IAW AFI 32-1043, Table 2.1, *Certification Weights and Speeds)* on new installations before accepting for operational use.

1.16.3. After installation of all anchors, tension the hook cable per normal operating procedures.

1.16.4. Evenly space the support discs on 6- to 10-foot centers along the entire length of the cable. Avoid placing a support disc at the centerline of the runway; otherwise, the tail hook may skip over the cable. Place the center support disc at least 2-feet on either side of the centerline and space the remaining discs from that point.

1.16.5. Provide obstruction marking and lighting, and arresting system location marking and lighting, according to the provisions of AFI 32-1042, *Standards for Marking Airfields,* and UFC 3-535-01, *Visual Air Navigation Facilities.*

1.16.6. If the system is installed for extended periods, take action to protect the system from the elements.

NOTE: MAAS units were designed for short-term contingency purposes, normally for periods less than one year. If original short-term plans change and the system will be installed longer than 1-year, remove and inspect the

anchors after 12-months. If the system is to be reinstalled in the same location, excavate and re-compact the area to CBR-15 or better, or select a new installation site. If initial planning reveals the need for an arresting system for one year or longer, a semi-permanent installation should be accomplished (foundations, tape tubes, and protective shelters). The 52-W-2291-901 BAK-12 energy absorber can and should be removed from the trailer and installed in the semi-permanent configuration to ease maintenance and reduce the footprint of airfield obstructions.

Chapter 2

LIGHT WEIGHT FAIRLEAD BEAM (LWFB)

2.1. Introduction. The LWFB Configuration Set design enhances ease of installation and capabilities of the MAAS. It presents a significantly decreased arresting gear profile at the runway edge reducing potential hazards to incoming and outgoing aircraft. The set has both soil and concrete anchoring capabilities. Read and understand all MAAS installation instructions in Chapter-1 before performing the LWFB installation.

2.1.1. The anchoring equipment supplied with the LWFB configuration set, together with installation equipment and tools supplied as part of the MAAS with the 52F1000-6 upgrade configuration set, provide all parts necessary to install and operate the hook cable arresting gear system.

2.2. Installation Planning. The particular operational need will dictate the location of anticipated sites. Personnel familiar with operational requirements must accomplish selection of the particular system arrangement.

CAUTION

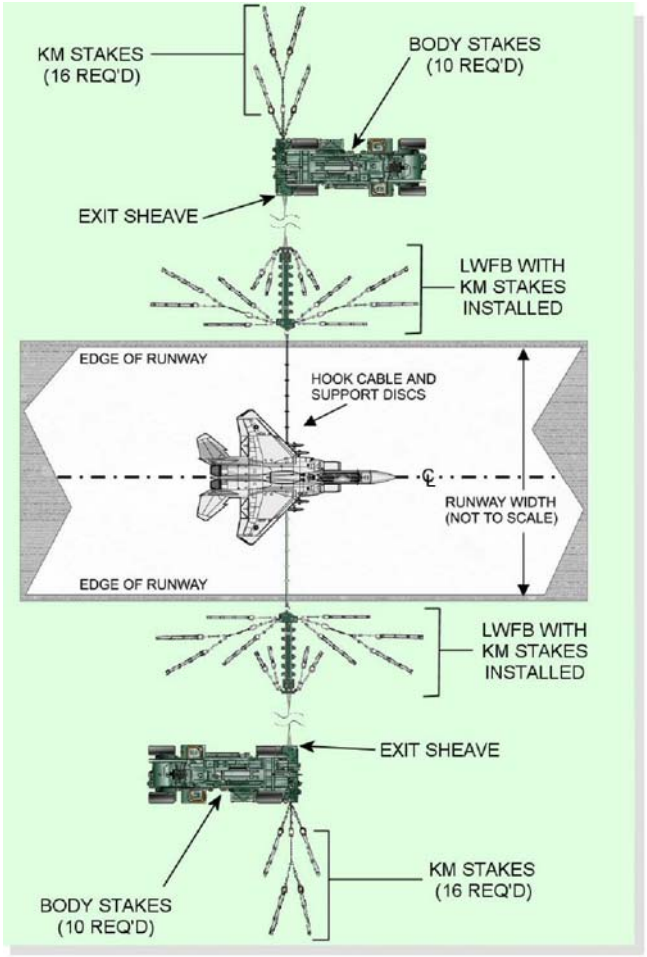
Notify Airfield Operations of any system irregularities and/or obstructions on or near the runway.

2.2.1. Operational Requirements. Air shows, runway construction projects, or other contingencies may require use of a MAAS to support aircraft operations at home station. During contingencies, operation of wide body aircraft may require additional wingtip clearances. In cases like these, aircraft arresting systems should not be installed at the runway edge. The Light Weight Fairlead Beam will allow you to site the MAAS trailer or an expeditionary BAK-12 in accordance with normal standards for siting aircraft arresting systems (a minimum of 275 feet from runway centerline).

2.2.2. Site Selection. The concept of the rapid installation of arresting gear requires preliminary siting to permit selection of a usable portion of the runway. Select installation sites that give an adequate paved surface for aircraft

run-out and a means of aircraft exit to clear the runway for additional incoming flights. Provide sufficient run-out to ensure the aircraft stays on the paved surface during arrestment (**Figure 2.1**).

Figure 2.1. MAAS and LWFB on Soil Base.



2.2.2.1. Elevations, slopes, and soil conditions can vary along the length of runway surfaces and taxiways. Avoid placing arresting gear where tape interference with obstructions during arrestment and tape rewind may occur. The selected site should be relatively flat and extend evenly on both sides of the runway for the required installation envelope, which extends to the stake installed furthest from the runway. This eliminates the need for grading. If site selection decisions did not account for site condition problems, inform the CE control center, or DCC, of the situation immediately.

2.2.2.2. Based on the above information, the Wing or Installation Operations Center should pass information through the Survival Recovery Center (SRC), CE control center, or DCC in order to make appropriate installation, operation, and maintenance decisions. Siting considerations that may affect your site preparation, installation, and operation are:

2.2.2.2.1. The need for additional wing clearances for wide-bodied aircraft

2.2.2.2.2. Purchase tape and cable lengths

2.2.2.2.3. Unidirectional or bidirectional engagement requirements

2.2.2.2.4. Requirement for rapid recycle operations

2.2.2.3. Upon receiving the coordinates of the installation location, identify the surface type and installation method required. The basic types of LWFB surface installations are soil and concrete.

2.2.2.4. Decisions on site selection should consider additional resource requirements when:

2.2.2.4.1. Installing the MAAS on unprepared surfaces, especially when heavy equipment operations are required to remove soil crowns, projections, deep ruts, craters, and/or crater upheavals that interfere with the tape run-out and tape sweep area

2.2.2.4.2. Heavy equipment operations are required to eliminate transverse slopes that exceed the operating limits of the MAAS/LWFB

2.2.3. Soil Conditions. The LWFB requires a CBR of at least 7 on undisturbed or compacted soil. Performing a full CBR test may not be possible during a deployment, but an engineering technician trained in the use of a

Dynamic Cone Penetrometer, which provides comparable readings, can determine soil suitability. As part of bare base planning, conduct a pre-site survey, which includes identification of low bearing pressure soils. Areas 100 to 200 feet from the runway have a greater chance of having native soil, which may affect the MAAS installation location when installed with a fairlead beam.

WARNING

Do not reinstall the LWFB at a previously used installation site. Significant reduction of soil bearing quality occurs following removal of anchors. Perform each installation at a new site, or excavate and compact the old site to a CBR of 15 or better.

2.2.4. Manpower Requirements. A 7-member work force will accomplish the installation and their responsibilities are in the next three paragraphs. Additional labor and equipment is necessary when the installation site requires earthwork to meet slope requirements.

2.2.4.1. The Arresting System Crew Chief has the overall responsibility for the installation and must utilize all personnel effectively to minimize installation time. Different team members, as directed by the crew chief, should perform many of the installation steps simultaneously. Training, practice, and safety are essential to minimize installation time.

2.2.4.2. One Engineering Craftsman, using surveying equipment, verifies that the installation site meets minimum and maximum slope requirements and sites system component locations. Plan to have the Engineering Craftsman provide site surveyor support for precision alignment of the fairlead beam centerline with the trailer's runway edge sheaves. Use the string line alignment method when an Engineering Craftsman and surveying equipment is not available and as a last resort.

2.2.4.3. Divide remaining team members into two teams. Two arresting system crewmembers and the Team-Chief make up Team-1 and are responsible for locating the lightweight fairlead beams and MAAS trailers at the location verified by the Engineering Craftsman. At this time, the three remaining arresting system crewmembers (Team-2) clear the tape sweep area and installation sites of foreign objects and obstructions. When the MAAS trailers are in position and lowered, Team-2 installs the MAAS anchoring hardware. Team-1 then positions the LWFBs, reeves the tape through the beams, connects the hook cable, and performs preliminary alignment procedures. Team-2 installs the outboard anchoring system while Team-1 performs tape pullouts and final alignment of the beam.

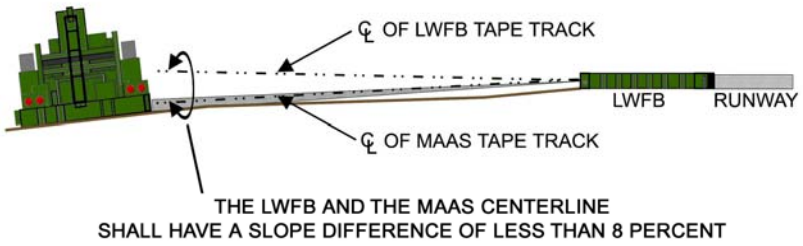
2.3. Site Preparations. It may be necessary to perform minor leveling of the ground surface around and under the MAAS and/or the LWFB to ensure there is no interference with the tape path.

2.3.1. Avoid placement of the LWFB such that there will be tape interference with obstructions and sharp objects such as stones and airfield lighting fixtures during arrestment and rewind. The minimum area swept by the tape can be determined by sighting a straight line from the exit sheave position to a point 990 feet or 1200 feet down the centerline of the runway in the direction of the arrestment (see **Figure 1.9**).

2.3.2. The space between the rear sheave housing of the LWFB and the edge sheave of the MAAS trailer must not exceed an 8% slope. Slopes exceeding 8% will cause tape-tracking problems (**Figure 2.2**). The MAAS must be level with or lower than the rear of the LWFB or standard Fairlead beam to prevent any lifting action on the rear of the LWFB, or standard Fairlead beam, during aircraft engagement.

2.3.3. It is desirable that the tape centerline projection from the LWFB exit sheaves angle to project through a window 1 to 4 feet above the runway crown (**Figure 1.11**). ***Exception***: The projection should be above the runway centerline when offset to one side of the crown.

Figure 2.2. Angle of Decline between MAAS and Fairlead Beam.



2.3.4. The system can be inclined from a negative (for single slope runways) to a positive slope. Most runways have a transverse slope of 1 to 1.5% and the slope of the LWFB can be as much as 3% more on runways up to 200 feet and up to 2.3% more on runways up to 300 feet wide.

2.3.5. The edge of the runway surface must not extend higher than the MAAS or Fairlead beam sheave (**Figure 1.10**). Additional fill, leveling, and compaction are required to bring the runway shoulder to an acceptable grade if it is lower than the runway surface.

2.3.6. The crew chief ensures the slope falls within the minimum and maximum requirements by having Engineering personnel, using surveying equipment, verify that the site meets installation requirements.

2.4. Basic Configuration and Layout. The basic configuration for the MAAS and LWFB is based on operational needs and siting requirements provided by the Wing or Installation Operations Center.

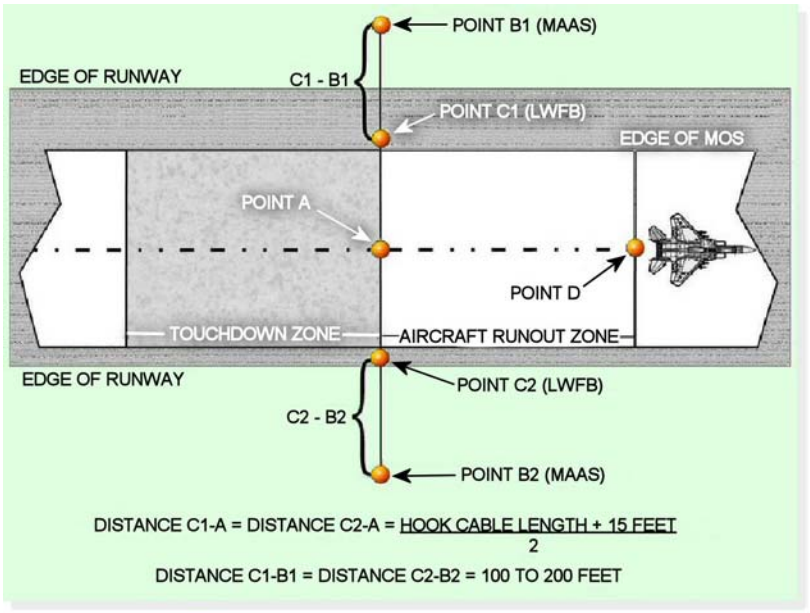
2.4.1. Siting Centerline, Hook-cable Location, and Run-out Zone. Follow procedures in paragraphs 1.4.1 thru 1.4.6 of Chapter-1 to layout the runway centerline, hook cable location, and run-out zone.

2.4.2. Siting System Components.

2.4.2.1. LWFB. When anchoring in soil or on a concrete runway, the distance from **Point-A** at the MOS centerline to the leading edge of the exit sheave of each LWFB, is the cable length plus 15 feet, divided by 2 (**Figure 2.3**).

Distance **C1** to **A** = $\frac{\text{cable length + 15 feet}}{2}$ = Distance **C2** to **A**

Figure 2.3. Establishing MAAS and LWFB Set Points



2.4.2.1.1. Example-1: If planning to use a 153-foot cable on a 150-foot wide runway, use 15 feet of exposed tape to center the cable between runway edge sheaves. Distance **C1-A** and **C2-A** will be 84 feet each, which meets the planning factor for cable length to be 90% of the distance between edge sheaves. This factor prevents adverse cable harmonics and tail hook skip as described in paragraph 1.4.7.

2.4.2.1.2. Example-2: If planning to use a 153-foot cable on a 200-foot wide runway, 47 feet of tape is required for centering the cable between runway edge sheaves. In this instance, the cable does not meet the 90% planning factor described in example 1, or the 80% **minimum** criteria. A

longer cable (195- or 205-foot) must be used, or inform the control center of the deficiency if a longer cable is not available.

2.4.2.2. MAAS Trailers. The MAAS trailers are located at **Set Points-B1** and **-B2** at the setback distances of **C1-B1** and **C2-B2** (**Figure 2.3).** Under normal operations, the MAAS trailer must be set back at least 275 feet from the runway centerline.

NOTE: An airfield waiver is required if the MAAS trailer is less than 275 feet from the centerline. MAJCOM/CV, or equivalent, is waiver authority (except for construction waivers and air shows when Installation Commander has waiver authority).

2.4.2.3. Alignment. An Engineering Craftsman using surveying equipment should align the trailers and LWFBs on a line perpendicular to the MOS centerline running through Set Point-A. If Engineering Craftsman and surveying equipment is not available, use the string-line alignment procedures in paragraph 1.4.7.1 to establish the LWFB Set Points-C1 and -C2.

2.4.2.3.1. After determining distances A-C1 and A-C2, establish Set Point-C1 for the LWFB and temporarily mark this point. Extend this line in the opposite direction from Point-A, and perpendicular to the MOS centerline, to the distance C2-A to establish Set Point-C2 for the other LWFB. Temporarily mark this point.

2.4.2.3.2. If an Engineering Craftsman and surveying equipment is not available, use the following string-line alignment procedures to establish MAAS trailer Set Points-**B1** and **-B2**.

2.4.2.3.3. A team member at **Point-A** visually aligns two team members measuring the setback distance from **Set Point-C1** to establish **Set Point-B1** for the MAAS trailer**.** Temporarily set a small wooden stake or other marker at this set point.

2.4.2.3.4. Repeat this step starting at **Set Point-C2** to establish MAAS trailer **Set Point-B2**. Temporarily set a small wooden stake or other marker at this set point.

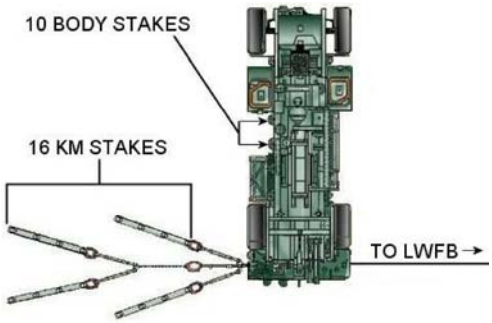
2.4.2.3.5. When finished, ensure **Points-C1, -B1, -A, -C2,** and **-B2** form a straight line perpendicular to the runway centerline.

WARNING

Following the MAAS installation, tape stack height measurements must be within the requirements for the runout of the system chosen. Maximum allowable tape stack-height measurements are found in Table 5-5 in both T.O. 35E8-2-5-1 for a 1200’ runout and T.O. 35E8-2-10-1 for a 990-foot runout.

2.5. MAAS Trailer Installation on Soil. Installation of the MAAS on a soil surface with a CBR of more than 7 is accomplished by installing body stakes at ten MAAS stake pockets and two sets of KM stake lines using a double 4-stake system (**Figure 2.4**), for a total of 26 stakes.

Figure 2.4. Detailed Layout of 26-Stake System.



WARNING

Use proper personal protective equipment such as hearing and eye protection, work gloves and safety toe boots when operating the HPU and hydraulic power equipment or serious bodily injury may occur.

2.5.1. With trailers positioned and lowered as described in paragraphs 1.5 and 1.6, remove required installation tools, hardware, and work stands stored on each trailer (**Table 2.1**). Remove rear bracket of the stake storage rack and the nine moil-point bushings.

2.5.2. Connect the 50-foot hydraulic hose to the right side HPU and the quick disconnect block. Ensure that the quick disconnect fittings are clean before connecting. ***NOTE:*** When equipped with the ETL 98-10 upgrade, the MAAS will have the Stanley stake driver and does not require the drive shank and stake driver. Throughout the following instructions, when mention is made of using a hydraulic breaker with a drive shank and stake driver, a Stanley stake driver may be used in lieu of the a hydraulic breaker.

2.5.3. Lower the rear wheels to the ground to facilitate installation of the body stakes.

2.5.4. Install 1-1/4 inch hex drive shank and 3 ½-inch stake driver on hydraulic breakers and connect breakers to the 50-foot HPU hoses. Ensure quick disconnect fittings are clean before connecting.

***NOTE*:** Properly orientate stakes before driving to facilitate removal (**Figure 1.38**).

Table 2.1. Installation Hardware and Tools for One MAAS Trailer.

Description	*Quantity*
Hardware	
Stake	26
Tie Stake Spacer	12
Stake Spacer	12
Stake Guide	4
Triple Turnbuckle fitting	2
Turnbuckle Assembly	5
Master Link	4
Trailer Adapter Fitting	1
Chain Sling	1

Table 2.1 continued on next page.

Tools	
Hydraulic Breaker	1
Hydraulic Power Unit	1
Hose Assembly	1
Hose Assembly	1
Stake Driver, 3-1/2 inch	1
Driver Shank, 1-1/4 inch Hex	1
Tape Measure, 100 foot	1
Adjustable Wrench, 20 inch	1
NOTE: Items and quantities shown are for installation of one MAAS trailer unit, and supplied with each unit.	

2.5.5. Using the hydraulic breakers and work stands (if required), install the ten stakes in the stake body pockets located along the perimeter of the trailer (**Figure 1.39**). Drive stakes into the soil until painted portion of the stake reaches ground level (**Figure 1.40**). The minimum acceptable depth a stake can be driven is 36 inches.

CAUTION

If work stands are used, a third person is required to steady the stand and operator during use of the hydraulic breaker.

2.5.6. After installation of the body stakes, return the axle support frame to its fully raised position.

2.5.7. Install a trailer adapter fitting on the left rear anchor point and then attach the triple-turnbuckle fitting to the trailer adapter fitting (**Figure 2.5**).

2.5.8. Adjust turnbuckles to approximately 36 inches in length. Attach the locknut end of each of three turnbuckles to the holes of the triple turnbuckle fitting (**Figure 2.6**).

Figure 2.5. Trailer Adapter Fitting and Triple Turnbuckle Fitting.

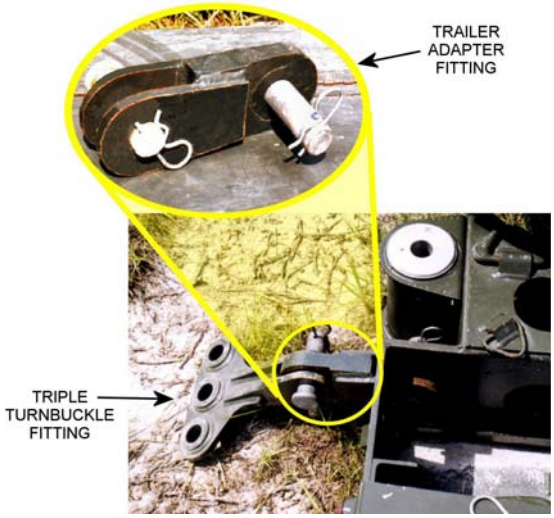


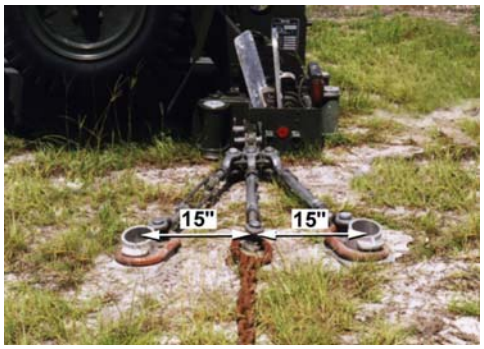
Figure 2.6. Turnbuckles Attached to Triple-Turnbuckle Fitting.

2.5.9. Install one chain sling to the middle turnbuckle. Pull the chain taut away from the trailer and perpendicular to the long side of the trailer body (**Figure 2.7**).

Figure 2.7. Chain Sling Attached to Center Turnbuckle.

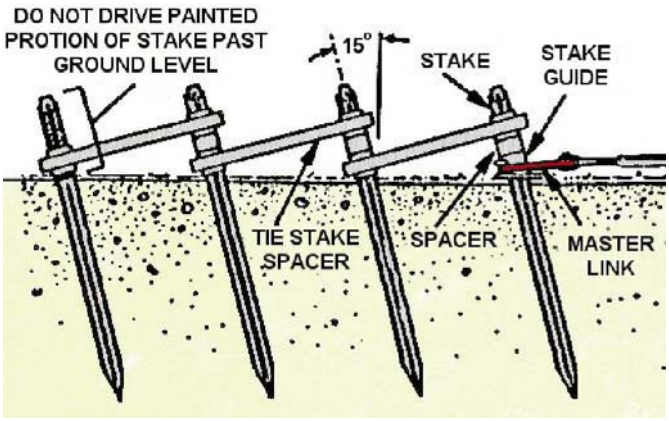
2.5.10. Install a master link around a stake guide and be sure the master link is under the retaining plate of the stake guide (**Figure 1.47**). Attach the free end of the master link to one of the outer turnbuckles. Connect a master link and stake guide to the opposite outer turnbuckle in the same fashion. Hold the chain sling taut and locate the two stake lines such that the centers of the stake guides are approximately 15 inches from either side of the chain sling (**Figure 2.8**).

Figure 2.8. Locating the Front Stake Lines.



2.5.11. Install a four-stake KM stake-line on both sides of the chain sling as described in paragraph 1.9.12 (**Figure 2.9**). Tighten both the turnbuckles equally to remove any slack in the outrigger, but do not over-tighten it to cause the trailer to move.

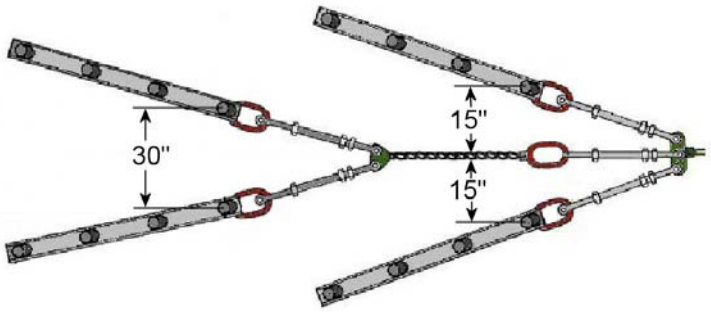
Figure 2.9. Four-Stake KM Stake-Line.



2.5.12. Install a triple-turnbuckle fitting to the free end of the sling chain. Attach the locknut end of two turnbuckles, adjusted to 36 inches, to the outer holes of the fitting. Install a master link around a stake guide and be sure the master link is under the retaining plate of the stake guide. Attach the free end of the master link to one of the turnbuckles. Connect a master link and stake guide to the opposite turnbuckle in the same fashion. Install the two stake lines coming off the triple-turnbuckle fitting at the end of the chain sling such that the stake guides are approximately 15 inches away from, and on both sides of, a line that would extend from the chain line (**Figure 2.10**).

2.5.13. Install the two intermediate stake lines as described in paragraph 1.9.12 plus an additional stake. Tighten both turnbuckles equally to remove any slack in the outrigger, but do not over-tighten it to cause the trailer to move.

Figure 2.10. Locating the Rear Stake Lines.



2.5.14. Perform a final tightening check on all the turnbuckles and tighten the turnbuckle locknuts. Repeat the installation actions described above for the trailer on the opposite side of the runway.

2.5.15. After the installation is complete, ready the MAAS for use following instructions in paragraph 1.16.

2.6. LWFB Installation on Soil. Install the LWFB (**Figure 2.11**) on a soil surface (with a CBR of at least 7) with 12 body-stakes and 4 sets of double KM stake lines totaling 52 stakes. This installation method can support heavyweight fighter aircraft and bidirectional operations. The hardware and tools listed in **Table 2.2** are required to install one LWFB in soil.

2.6.1. Attach the LWFB to a 1,000-pound capacity sling and move it into position with a front-end loader.

***NOTE*:** No matter how precise the alignment of the MAAS and LWFB, perform an operational check to ensure proper alignment and tape tracking through the beam. The placement is not complete until the operational check has taken place.

Figure 2.11. LWFB on Soil—Bidirectional Operation.

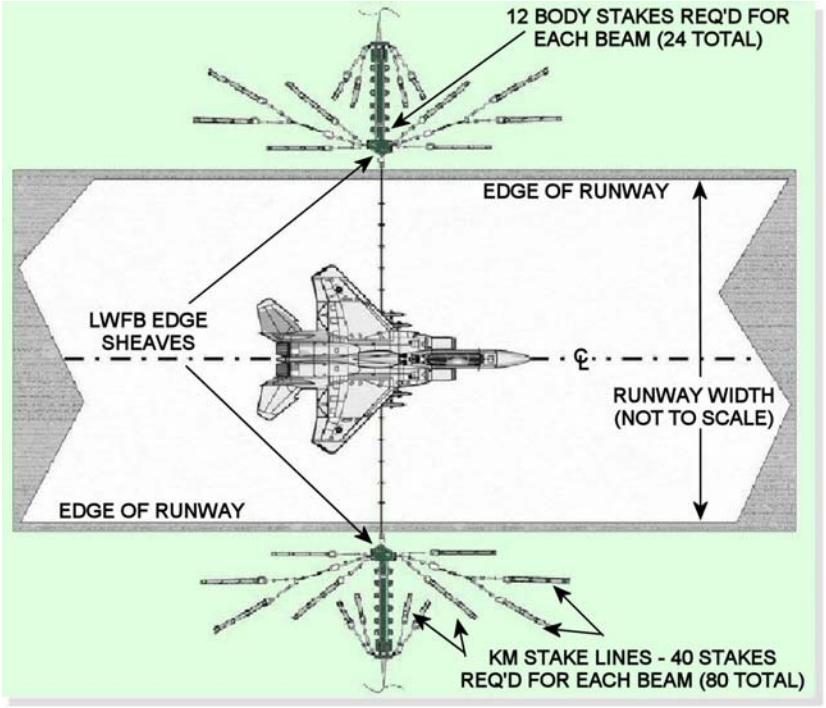


Table 2.2. Soil Installation Hardware and Tools for One LWFB.

Description	*Quantity*
Hardware	
Stake	52
Tie Stake Spacer	28
Stake Spacer	28
Stake Guide	12
Triple Turnbuckle fitting	6

Table 2.2 continued on next page.

Turnbuckle Assembly	14
Master Link	12
Chain Sling	2
Anchor Fitting	2
Shoulder Screw	4
Hex Nut	4
Tools	
Hydraulic Breaker	1
Hydraulic Power Unit	1
Hose Assembly	1
Hose Assembly	1
Stake Driver, 3-1/2 inch	1
Driver Shank, 1-1/4 inch Hex	1
Tape Measure, 100 foot	1
Adjustable Wrench, 20 inch	1
NOTE: Items and quantities shown are for installation of one MAAS trailer unit, and supplied with each unit.	

2.6.2. Install a triple-turnbuckle fitting to the four anchor points, two each on the front and rear sheave housings, and adjust all 14 turnbuckles to approximately 36 inches between the centers of the clevis pins.

2.6.3. Attach the locknut end of three turnbuckles to the triple-turnbuckle fitting at the left side of the front sheave housing. Attach the chain sling to the middle turnbuckle.

WARNING

Use proper personal protective equipment such as hearing and eye protection, work gloves and safety toe boots when operating the HPU and hydraulic power equipment or serious bodily injury may occur.

2.6.4. Start the first stake line using the turnbuckle closest to the runway and install it parallel to the runway edge. Install the 4-stake KM stake line following procedures starting in paragraph 1.9.12. ***NOTE:*** Proper stake orientation will facilitate removal (**Figure 1.50**).

2.6.5. Pull the chain sling attached to the center turnbuckle taut and adjust its location so that the line formed by the turnbuckle and chain sling is 15 inches from the center of the stake guide closest to the runway. Attach a master link and stake guide to the turnbuckle furthest from the runway. Adjust the position of the stake guide 15 inches from the line formed by the turnbuckle and chain sling. Now, install the second 4-stake KM stake line (**Figure 2.12**).

2.6.6. Install a triple-turnbuckle fitting on the end of the chain sling and install two turnbuckles, one on each outside hole. Attach the free ends of two master links to the turnbuckles and install the master links around two stake guides. Pull the two stake guides taut and locate them so that the centers of the stake guides are 30 inches apart and located equally on each side of the chain's extended centerline. Now, install the two 4-stake KM stake lines (**Figure 2.13**).

Figure 2.12. Locating First Set of Front Stake Lines.

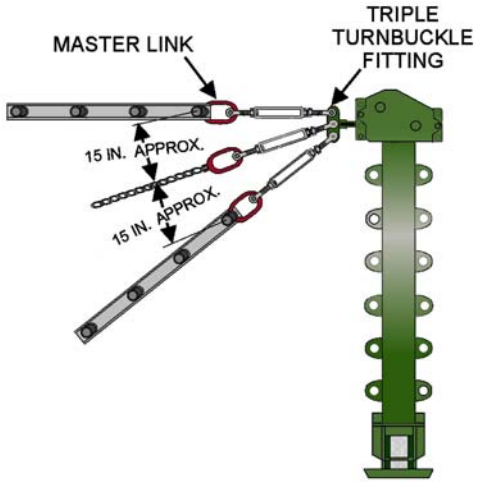
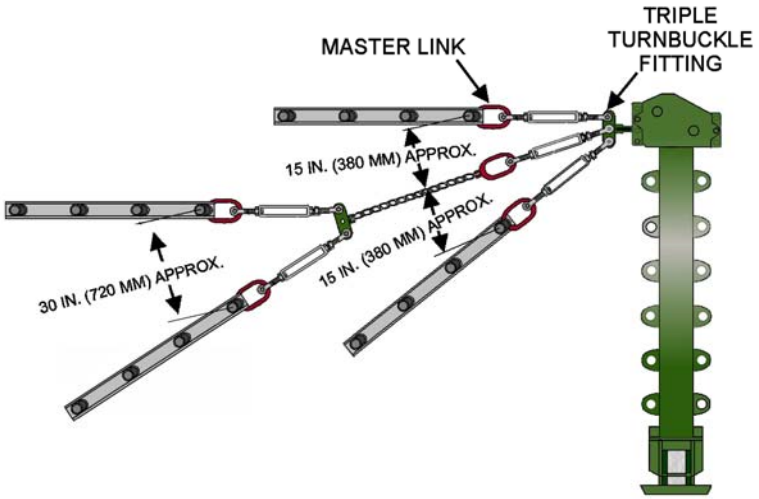


Figure 2.13. Locating Second Set of Front Stake Lines.



2.6.7. Repeat the above steps for the KM stake lines for the right side of the front sheave housing.

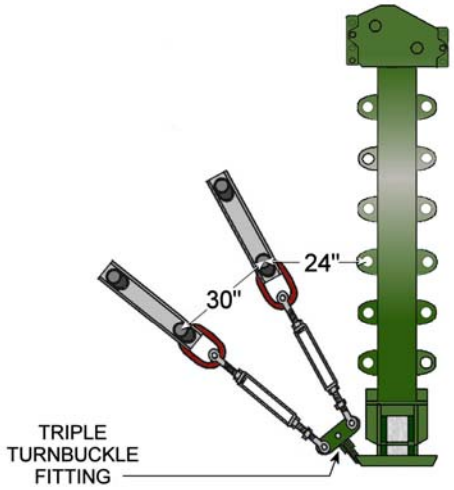
2.6.8. After installation of all front anchor lines, tighten the front turnbuckles to remove any slack in the outriggers, but do not over-tighten them, which would cause the beam to move.

2.6.9. Attach two turnbuckles to the triple-turnbuckle fitting on the left side of the rear sheave housing.

2.6.10. Attach two master links around two stake guides and attach the free ends of the master links to the two turnbuckles. Pull the stake guide closest to the beam taut and measure approximately 24 inches between the center of the stake guide and the center of the third body stake hole (**Figure 2.14**). Now, install the 2-stake KM stake line following the procedures starting in paragraph 1.9.15.

2.6.11. Pull the remaining stake guide and master link taut on the turnbuckle and locate its center 30 inches from the center of the stake guide closest to the LWFB. Now, install the second 2-stake KM stake line (**Figure 2.14**).

Figure 2.14. Locating the Rear Stake Lines.



2.6.12. Repeat the four steps above for the two KM stake lines on the right side of the rear sheave housing.

2.6.13. Tighten all rear turnbuckles to remove any slack in the outriggers, but do not over-tighten them enough to cause the beam to move.

2.6.14. Before installing the LWFB body stakes, release the reel brakes on each energy absorber and pull a sufficient length of tape from each trailer and reeve the tape through the LWFB making sure not to put a full twist in the tape (see **Figure 2.15**). Install the tape connectors in accordance with T.O. 35E8-2-10-1.

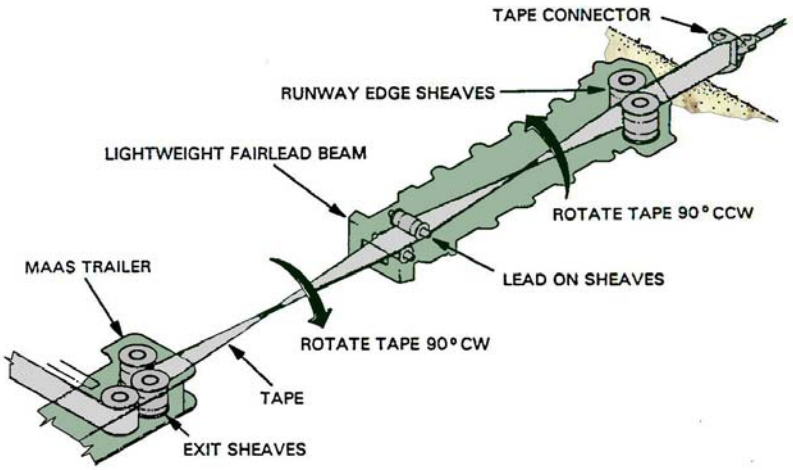
2.6.15. Using a suitable tow vehicle, pull the tape out 300 feet in both directions.

2.6.16. Observe while the tape passes through the LWFB lead-on sheave during pull out and rewind operation. Adjust the rear sheave housing turnbuckles to center the tape on the lead-on sheave. Repeat this process until achieving proper alignment.

2.6.17. Tighten the locknuts on the turnbuckles.

2.6.18. Using the hydraulic breakers and work stands (if required), install the 12 stakes through the LWFB body stake pockets.

Figure 2.15. Tape Reeved Through LWFB.



2.6.19. After the installation is complete, ready the MAAS for use following instructions in paragraph 1.16.

2.7. LWFB Installation on Concrete. Installation on a concrete runway is possible using four additional concrete anchor plate assemblies, two additional triple turnbuckle fittings, and two additional bolts for each LWFB (**Figure 2.16** and **2.17**).

CAUTION

Before installing the LWFB on existing concrete, have a pavement evaluation performed to determine if the concrete will withstand the arresting loads. The LWFB weighs considerably less than the MAAS, which results in higher loads exerted on the anchors during arrestment. Concrete strength must be equivalent to PCC foundations described in paragraph 2.8.1.

Figure 2.16. LWFB Concrete Installation.

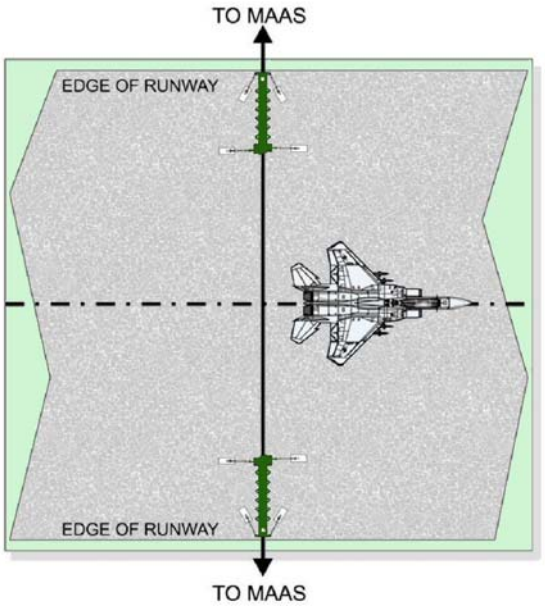
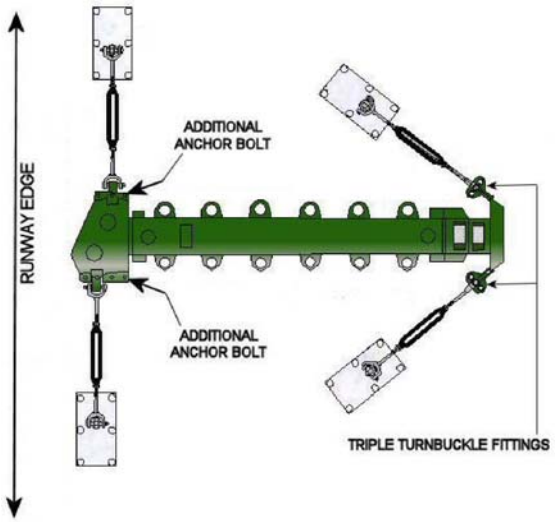


Figure 2.17. Typical LWFB Anchoring Configuration on Concrete.



2.7.1. The anchoring mechanism is the same as used to anchor the MAAS on concrete described in paragraph 1.7. Two additional concrete installation hardware kit assemblies (**Table 2.3**), based on Installation Kit 52-D-7800-107, and two additional anchor bolts at the front sheave housing are required for each LWFB (**Figure 2.17**). This installation method can support heavier weight fighter aircraft operations and is bidirectional.

Table 2.3. LWFB Concrete Installation Kit Components (one beam).

Description	*Quantity*
Anchor Plate	4
Taper Bolt	24
Washer, Flat	24
Hitch Pin Clip	8
Turnbuckle	4
Triple Turnbuckle Fitting	2
Nut	40

2.7.2. Attach the LWFB to a 1,000-pound capacity sling and move it into position with a front-end loader. Perform initial alignment on points identified during siting procedures described in paragraph 2.4.

***NOTE*:** No matter which siting method is used and how precise the MAAS and LWFB have been sited and placed into position, the MAAS with LWFB must have an operational check performed to ensure the tape is properly aligned and tracking through the beam. The placement of the beams or MAAS is not complete until the operational check for tracking has taken place.

2.7.3. Install a drill bit in the hydraulic hammer drill. Connect the hydraulic hammer drills to the 50-foot hoses attached to the HPUs. Ensure the quick disconnect fittings are clean before connecting.

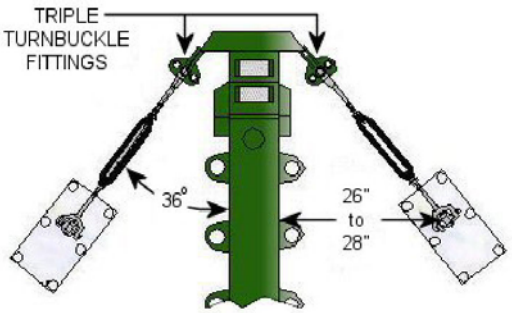
2.7.4. Install a triple-turnbuckle fitting to the rear sheave housing anchor points.

2.7.5. Adjust all four turnbuckles to approximately 39 inches between the centers of the clevis pins. Attach the locknut end of the turnbuckles to the front sheave housing anchor points and the center hole of the triple-turnbuckle fitting of the rear sheave housing anchor points.

2.7.6. Attach the other end of turnbuckles to the anchor plates. Align front anchor plates such that the long edge of the plate is parallel to a line drawn across the front of the beam and parallel to the edge of the runway (**Figure 2.17**).

2.7.7. Align rear anchor plates such that anchor points on the plates are located equal distance on each side of the rear sheave housing at a 36° angle, which is approximately 26 to 28 inches from the edge of the beam near the second body stakeholder (**Figure 2.18**).

Figure 2.18. Rear Anchor Plate Alignment on Concrete.



WARNING

Use proper personal protective equipment such as hearing and eye protection, work gloves and safety toe boots when operating the HPU and hydraulic power equipment or serious bodily injury may occur.

2.7.8. Install plates following the steps in paragraphs 1.7.7 thru 1.7.10.

CAUTION

Install all six anchor bolts to provide the proper safety margin for heavier weight aircraft. Should problems occur during an emergency installation (i.e., drill encounters unexpected re-bar) a minimum of four properly installed bolts will meet 40,000-pound arrestment loads at 150 knots. When time permits, upgrade to full capacity with six bolts per anchor plate.

2.7.9. Perform a tracking alignment check by following procedures in paragraphs 2.6.15 thru 2.6.19.

2.7.10. Using the rear bolt holes on both sides of the front sheave housing as guides, drill two additional holes. Install two anchor bolts (**Figure 2.19**) using the procedures in paragraph 1.7.8 and 1.7.9.

Figure 2.19. Anchor Bolt Location on Front Sheave Housing.

2.7.11. Store the installation tools and equipment after completing the installation. Perform the same actions for the beam on the opposite side of the runway.

2.7.12. After the installation is complete, ready the MAAS for use following instructions in paragraph 1.16.

2.8. LWFB Installation with MAAS on Concrete Foundation. Construct foundations when expecting multiple or frequent installations for a single location, or where the CBR of the soil is less than 7. Site the foundations to meet the same requirements in paragraphs 2.5 and 2.6. Use the following requirements to construct foundations (**Figure 2.20**).

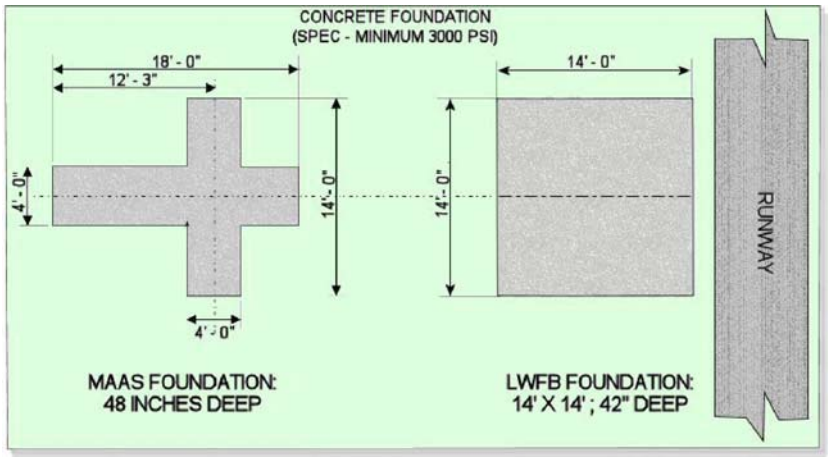
2.8.1. LWFB foundation:

2.8.1.1. Width of foundation is 14 feet wide.

2.8.1.2. Length of foundation is 14 feet long.

2.8.1.3. Depth of foundation is 3.5 feet deep.

Figure 2.20. LWFB and MAAS PCC Foundations.



2.8.1.4. Place #5 rebar on 12-inch centers both ways. Offset to avoid anchor bolt locations. Provide a minimum 4-inch cover.

2.8.1.5. Use 3,000-PSI PCC with water to cement ratio of not more than 0.45

2.8.1.6. Use the same anchor installation procedures as described in paragraph 2.7.

2.8.2. MAAS foundation: To construct MAAS cruciform foundation, follow procedures in paragraph 1.15.

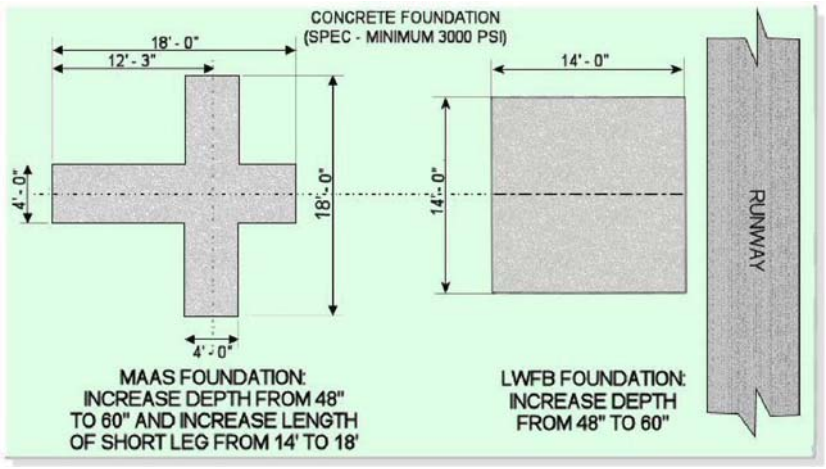
2.8.3. When constructing the foundations in low bearing pressure soil, apply the following differences to the above procedures (**Figure 2.21**):

2.8.3.1. LWFB foundation: increase the depth of the foundation from 42 inches to 60 inches.

2.8.3.2. MAAS foundation: increase the depth from 48 inches to 60 inches and increase length of short leg from 14 feet to 18 feet.

2.8.4. Follow the installation instructions in paragraph 2.7 to install the LWFB on concrete foundations.

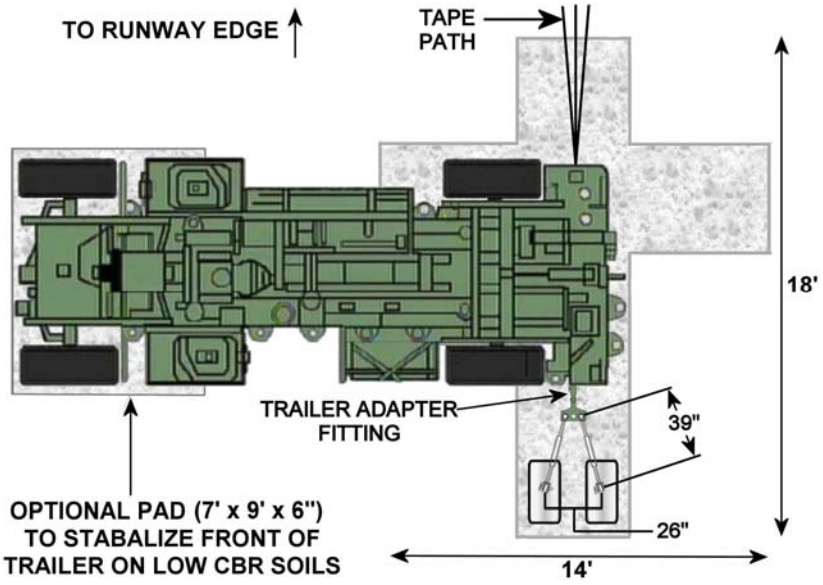
Figure 2.21. PCC Foundations in Low Bearing Pressure Soil.



2.8.5. Installation of the MAAS on a setback PCC foundation in conjunction with the LWFB has a different anchoring layout than described in paragraph 1.15. The holding strength of the six anchor bolts installed in a single anchor plate fall short of accommodating the maximum tape tension load. Two anchor plates are required on a PCC foundation installed 180 degrees from the leadoff sheave at the pretension anchor point. This configuration is required to accommodate the maximum tape tension of 105 kips. Compact and level the surface to match the foundation height to support the entire length of the trailer. If installed on low CBR soil, support the front of the trailer with an addition concrete pad (**Figure 2.22**). Install the two anchor plates as laid out in **Figure 2.22** using the concrete anchor installation procedures described in paragraph 1.7.

2.8.6. After the installation is complete, ready the MAAS for use following instructions in paragraph 1.16.

Figure 2.22. Cruciform Platform Setback Configuration.



Chapter 3

STANDARD FAIRLEAD BEAM

3.1. Introduction. The fairlead beam presents a significantly decreased arresting gear profile at the edge of the runway, thus reducing potential hazards to incoming and outgoing aircraft. The beams do not come with the MAAS or LWFB kits and must be procured separately. The standard fairlead beam is anchored with either a KM Stake Line System (**Figure 3.1**) or with a deadman anchoring system (**Figure 3.2**). In addition to the following installation instructions, read and understand all MAAS installation instructions in Chapter-1 before attempting to perform arresting gear installations.

Figure 3.1. Standard Fairlead Beam on Soil with KM Stake Lines.

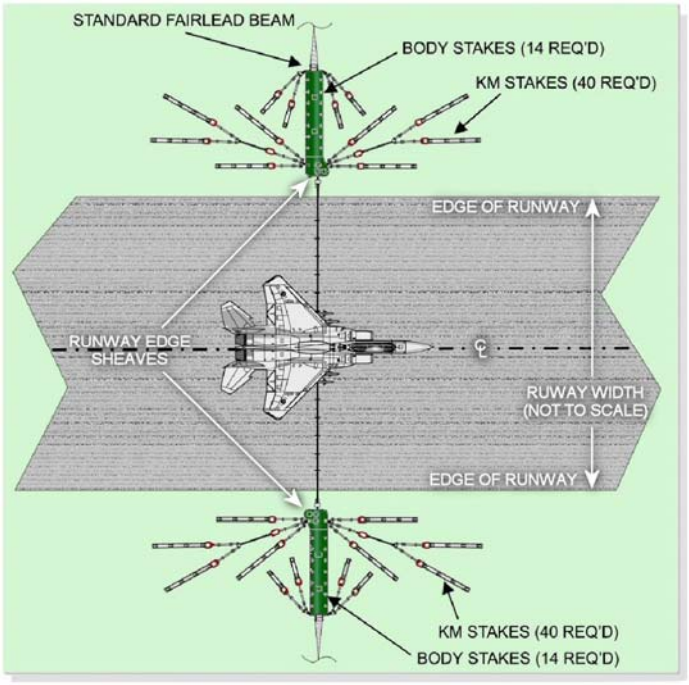
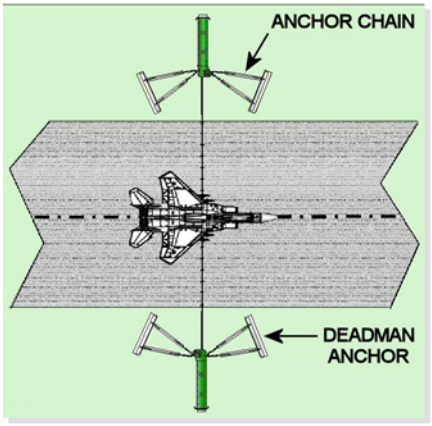


Figure 3.2. Standard Fairlead Beam on Soil with Deadman Anchors.



3.2. Installation Planning. The particular operational need will dictate the location of anticipated sites. Personnel familiar with operational requirements must accomplish selection of the particular system arrangement. Follow the LWFB installation planning procedures in paragraph 2.2.

CAUTION

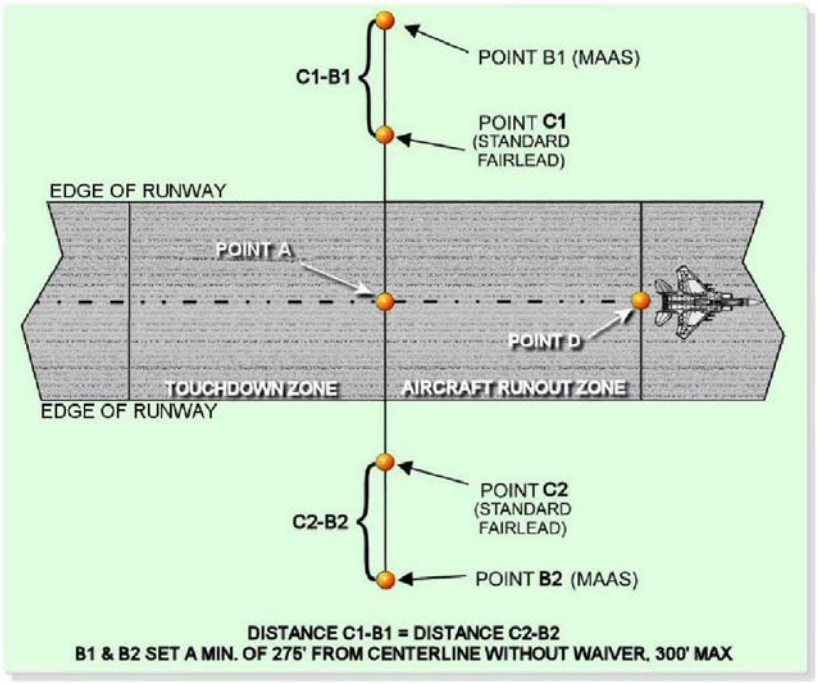
Notify Airfield Operations of any system irregularities and/or obstructions on or near the runway.

3.3. Site Preparations. It may be necessary to perform minor leveling of the ground surface around and under the MAAS and/or the LWFB to ensure there is no interference with the tape path. Follow the LWFB site preparation procedures in paragraph 2.3.

3.4. Basic Configuration and Layout. Basic configuration for the MAAS and standard fairlead beam is based on operational needs and siting requirements provided by the Wing or Installation Operations Center (**Figure 3.3**).

3.4.1. Siting Centerline, Hook-cable Location, and Run-out Zone. Complete procedures in paragraphs 1.4.1 thru 1.4.6 of Chapter-1 to layout the runway centerline, hook cable location, and run-out zone.

Figure 3.3. Basic Configuration and Layout.

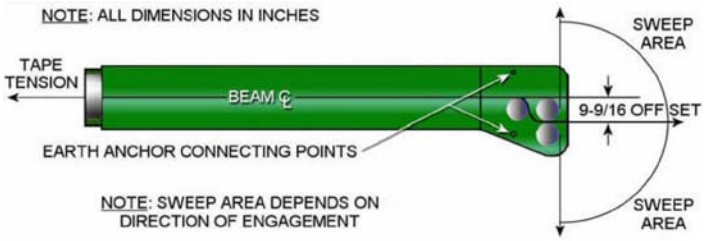


3.4.2. Siting System Components.

3.4.2.1. Standard Fairlead Beam with KM Anchoring System. The centerline of the standard fairlead beam lead-on sheaves and leadoff sheaves have a 9-9/16 inch built in offsets (**Figure 3.4**). To adjust for the offset, the fairlead beam and MAAS trailer on one side of the runway will have an offset double that of the beam from the original Point-A. This adjustment will make up the offsets for beams on each side of the runway.

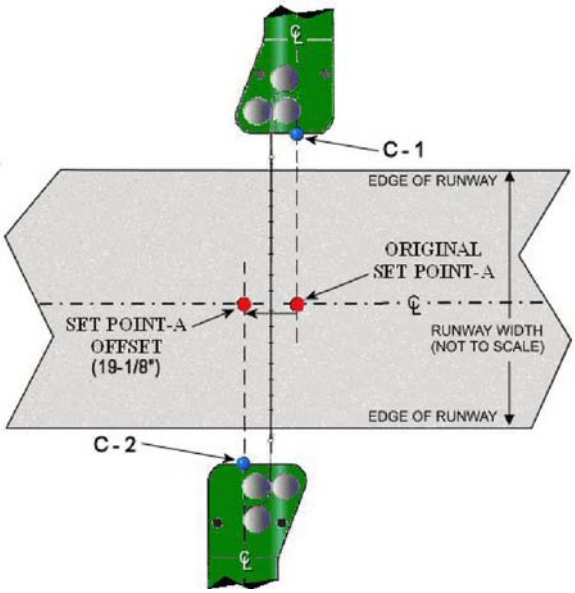
3.4.2.1.1. Establish Set Point-C1 in the same manner as for the LWFB in paragraph 2.4.2.

Figure 3.4. Standard Fairlead Beam Offset.



3.4.2.1.2. After establishing Set Point-C1, apply the offset when siting for Set Point-C2 as follows. While looking towards the second beam, move the transit 19-1/8 inches to the right of Point-A (**Figure 3.5**). Use this new Set Point-A to begin the line A-C2, which will be perpendicular to the MOS centerline. Establish Set Point-C2 at the predetermined A–C2 distance as determined in paragraph 2.4.2 (**Figure 3.3**).

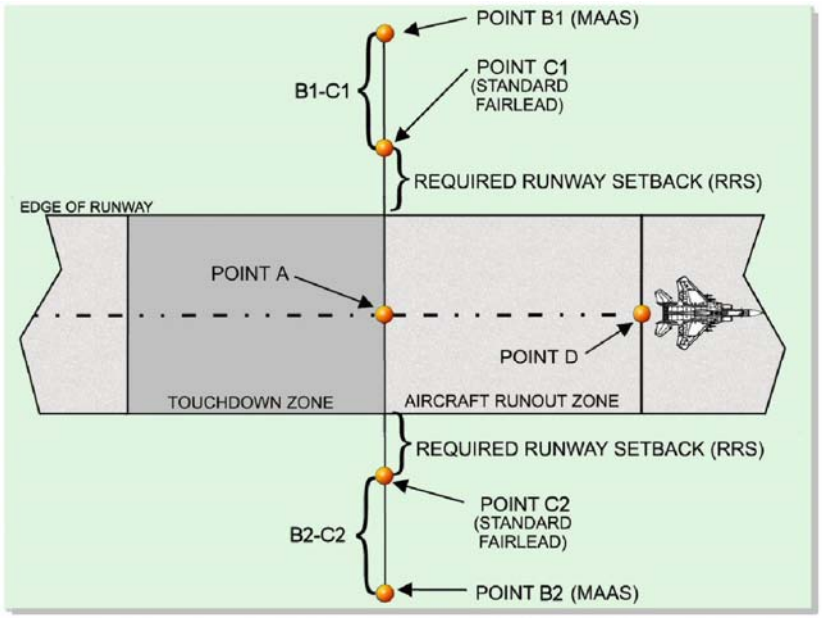
Figure 3.5. Layout of Standard Fairlead Beam



3.4.2.2. Standard Fairlead Beam with Deadman Anchoring System. To determine the location of the beams when using dead-man anchors in soil, add one-half the cable length to the required runway setback (RRS) distance from **Table 3.1**, and then subtract 20" (the distance between the beam front measuring point and the front anchor point). Use the following formula to calculate the location of Set Points-C1 and -C2 (**Figure 3.6**).

$$\text{Distance (C1-A)} = \frac{\text{Runway Width}}{2} + (\text{RRS} - 20 \text{ inches}) = \text{Distance (C2-A)}$$

Figure 3.6. MAAS and Standard Fairlead Beam Set Points.



DISTANCE C1-A = DISTANCE C2-A = $\frac{\text{RUNWAY WIDTH}}{2}$ + (RRS - 20 INCHES) [WITH DEADMAN]

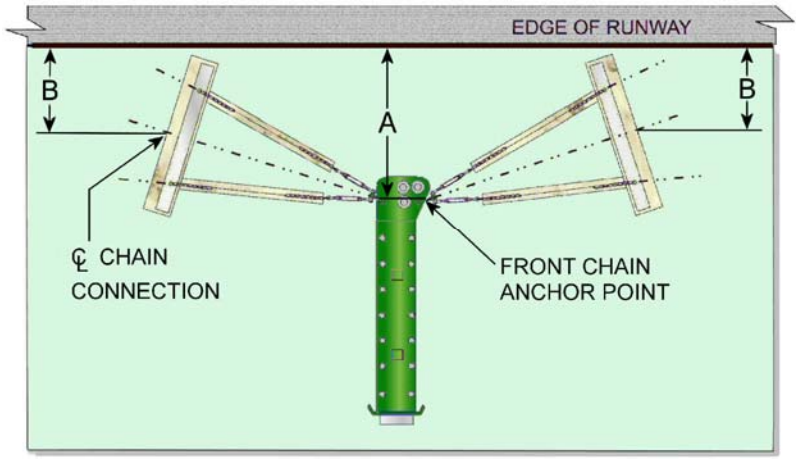
DISTANCE C1-B1 = DISTANCE C2-B2

B1 & B2 SET A MIN. 275' FROM CENTERLINE WITHOUT WAIVER, 300' MAX.

3.4.4.2.2.1. The RRS is the distance between the runway edge and the front anchor point of the beam (**Figure 3.7**). The runway width determines the

RRS distance—either 13 or 20 feet (**Table 3.1**). If site conditions create problems with dead-man excavation near the runway, or with protecting the integrity of runway pavement, make minimal adjustments to increase the RRS distance; ensure to adjust both beams equally. Make plans for the cable to be 90% of the distance between the front sheaves of the two beams. As a minimum, ensure the cable is at least 80% of the distance.

Figure 3.7. Required Setback for Deadman Anchors.



3.4.4.2.2.2. Perform the same steps just described to sight the second beam, but first, adjust for the beam offset as described in the KM anchoring system installation procedures in paragraph 3.4.2.1.

Table 3.1. Required Setback for Deadman Anchors.

Runway Width	*A Distance from runway edge to front anchor point*	*B Distance from runway edge to centerline of chain connection*
150 Feet	20’	12’ 6”
200 Feet	13’	5’ 6”
300 Feet	13’	5’ 6”

3.4.2.3. MAAS Trailers. Establish **Set Points-B1** and **-B2** to locate trailers. Position trailers so that they are at least 275 feet from the runway centerline (**Figure 3.6**). Use Set Point-A **offset mark,** described in paragraph 3.4.2.1, to site Set Point-B2.

***NOTE*:** While it is possible to install the MAAS up to 300 feet from the MOS centerline, limit the setback distances to reduce premature tape wear and minimize the need for extensive leveling of the ground surfaces between the MAAS and the standard Fairlead beam when excessive slopes are present.

3.4.2.4. Alignment. The preferred method for aligning MAAS trailers with standard fairlead beams is accomplished by using a transit. Use the string line method when unable to use the preferred method, and only under ideal conditions when **set Points-B1** and **-B2** are no more than 275 feet from the runway centerline. For set back distances exceeding 275 feet, or when conditions are windy and/or unable to keep a string line taut/straight, an engineering craftsman should use a transit for alignment.

3.4.2.4.1. Transit Alignment.

3.4.2.4.1.1. Set transit up on the MOS centerline at Point-A and zero instrument when aligned with Point-D (**Figure 3.6**).

3.4.2.4.1.2. Turn transit 90° to establish a perpendicular line to the MOS centerline.

3.4.2.4.1.3. Calculate the C1-A distance as described in paragraph 3.4.2.2., measure the distance from Point-A, and align Set Point-C1 with the transit. Temporarily mark Set Point-C1.

3.4.2.4.1.4. Pull a measuring tape from set Point-C1 for distance C1-B1 (**Figure 3.6**) and align Set Point-B1 with the transit. Temporarily mark this point. Set Points-A, -C1, and -B1 should now all be in a straight line.

3.4.2.4.1.5. While standing at Point-A and facing towards Set Point-C2, measure the 19-1/8 inch offset to the right of the original Point-A; temporarily mark this point.

3.4.2.4.1.6. Set transit up on the MOS centerline at Point-A offset and zero instrument when aligned with Point-D (**Figure 3.6**).

3.4.2.4.1.7. Turn transit 90° towards Set Point-C2 to establish a perpendicular line to the MOS centerline.

3.4.2.4.1.8. Calculate the C2-A distance as described in paragraph 3.4.2.2., measure the distance from Point-A, and align Set Point-C2 with the transit. Temporarily mark Set Point-C2.

3.4.2.4.1.9. Pull a measuring tape from set Point-C2 for distance C2-B2 (**Figure 3.6**) and align Set Point-B2 with the transit; temporarily mark this point. Set Points-A, -C2, and -B2 should now all be in a straight line.

3.4.2.4.2. String-line Alignment Method.

3.4.2.4.2.1. Follow the typical string line method (paragraph 1.4.7.2.) to establish **Set Point-C1** for the standard fairlead beam; temporarily mark this point.

3.4.2.4.2.2. The team leader at **Point-A** aligns the person at **Set Point- C1** with a second person to pull a tape for the setback distance **C1-B1**. Temporarily mark this point to establish **Set Point-B1,** the centerline of the MAAS leadoff sheaves.

3.4.2.4.2.3. The string team moves to opposite side of the runway.

3.4.2.4.2.4. Extend the original perpendicular line the distance **C2-A** on this side of **Point-A** to establish **Set Point-C2.** The team leader at **Point-A** faces **Set Point-C2** and directs the person at that point to measure off the required offset to the team leader's right and temporarily mark **Offset Point-C2.**

3.4.2.4.2.5. The team leader at **Point-A** aligns person at **Set Point-C2** with a second person to pull a tape for setback distance **C2-B2.** The team leader directs the person at that point to measure off the 19-1/8 inch offset to the team leader's right. Temporarily mark **Offset Point-B2** for the centerline of the MAAS leadoff sheaves.

***NOTE*:** When placing or positioning the standard fairlead beam prior to final anchoring, check beam and MAAS alignment with a transit or a string line. Run a string line from the temporary mark next to **Set Point-C1** (or **Set**

Point-C2, as applicable) to the temporary mark at MAAS **Set Point-B1** (or **Set Point-B2**, as applicable). The beam will be parallel to and centered under the string line.

WARNING

Following the MAAS installation, tape stack height measurements must be within the requirements for the runout of the system chosen. Maximum allowable tape stack-height measurements are found in Table 5-5 in both T.O. 35E8-2-5-1 for a 1200' runout and T.O. 35E8-2-10-1 for a 990-foot runout.

3.5. MAAS Trailer Installation on Soil. With trailers positioned at Set points-B1 and B2 and lowered in accordance with procedures in paragraphs 1.5 and 1.6, follow the trailer installation procedures in paragraphs 1.9 or 1.14, depending on the anchoring system and configuration being installed.

3.6. Standard Fairlead Beam Installation.

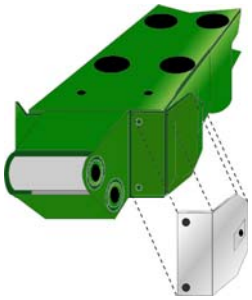
WARNING

Wear hearing and eye protection, work gloves and safety toe boots when operating the HPU and hydraulic power equipment or serious bodily injury may occur.

3.6.1. KM Anchoring System Installation. The standard fairlead beam installation on soil with a minimum CBR of 7 can be accomplished using the KM Anchoring System and body stakes, which require two additional stakes (54) than that of the LWFB to accommodate the beam's two additional body stake-pockets. To use this system with the standard fairlead beam, the beam must be fitted with two adapter brackets located on both sides at the rear

(lead-on) sheave of the beam (**Figure 3.8**). This installation method can support heavier weight fighter aircraft operations and is bidirectional.

Figure 3.8. Standard Fairlead Beam Adapter Bracket—Right Side.



3.6.1.1. Obtain installation hardware (**Table 3.2**) from the LWFB installation kit or acquire them separately for the standard fairlead beam installation. Use the installation tools found on the MAAS trailers. Perform the installation following the LWFB installation procedures in paragraphs 2.6.

Table 3.2. Standard Fairlead Beam KM Anchoring System Hardware.

DESCRIPTION	*QTY*
Fairlead Beam, Standard	2
Adapter Bracket	4
Cruciform Stake	108
Stake Spacer	56
Stake Guide	24
Tie Spacer	56
Turnbuckle	28
Master Link	24
Chain Sling Assembly	4
Triple Turnbuckle Fitting	12

3.6.2. Deadman Anchoring System Installation. Installation of the standard fairlead beam on a soil surface may be accomplished by installing body stakes and deadman anchors (**Figure 3.2**). There are 14 stakes located in the standard fairlead beam body and two deadman anchors located at the front anchoring locations of each beam. This installation method can support heavier weight fighter aircraft and bidirectional operations.

3.6.2.1. **Table 3.3** lists the material required to construct deadman anchors for one fairlead beam. Lay out deadman anchors per paragraph 3.4.2.2 and install the anchors as described in paragraph 1.14.

Table 3.3. Deadman Anchoring Materials.

Description	*Quantity*
Chain Anchor Assembly	4
Triple Turnbuckle Fitting	2
Turnbuckle	4
6” x 6” x 3/8” by 12’ steel angle backing plates (or suitable structural plate)	2
12’ Perforated Steel Planking (PSP)	4
12’ AM2 Matting Sheets	2

3.6.3. After the installation is complete, ready the MAAS for use following instructions in paragraph 1.16.

Chapter 4

MOBILE RUNWAY EDGE SHEAVE (MRES)

4.1. Introduction. Like the LWFB and standard fairlead beam, the MRES presents a significantly decreased arresting gear profile at the edge of the runway, thus reducing potential hazards to incoming and outgoing aircraft. An advantage of the MRES is that it has its own running gear, which makes it extremely mobile and a perfect match for the MAAS. In addition, the runway edge-sheave design has metal covers that turn the profile of the MRES into a low ramp, which allows aircraft to roll over the MRES safely if they stray from the surface of the runway or overrun.

4.1.1. The MRES is designed for mobile deployment and ease of installation, and is capable of being anchored on concrete or in soil, depending upon conditions found at the site (**Figure 4.1** and **4.2**). Do not install the system on soil if the anticipated period of service is longer than one year. The anchoring equipment supplied with the MRES system, together with the installation equipment and tools supplied as part of the MAAS aircraft arresting gear, provide all of the parts necessary to install and operate the mobile arresting gear system and the MRES. Regardless of the type of anchors used, the MAAS hydraulic power unit (HPU) provides power for the installation tools.

Figure 4.1. MRES and MAAS Installed on Concrete.

4.1.2. The installations detailed here are suitable for all arrestments, including bi-directional landings and aborted take-offs. No reduction in installation hardware is authorized for unidirectional installations.

Figure 4.2. MRES and MAAS Installed in Soil.

4.1.3. The MRES does not come with the MAAS; procure them separately. In addition to the following installation instructions, read and understand all MAAS installation instructions in Chapter-1 before attempting to perform arresting gear installations.

4.2. Installation Planning. The particular operational need and airfield layout will dictate the location of anticipated sites. Personnel familiar with operational requirements select the particular system arrangement.

CAUTION

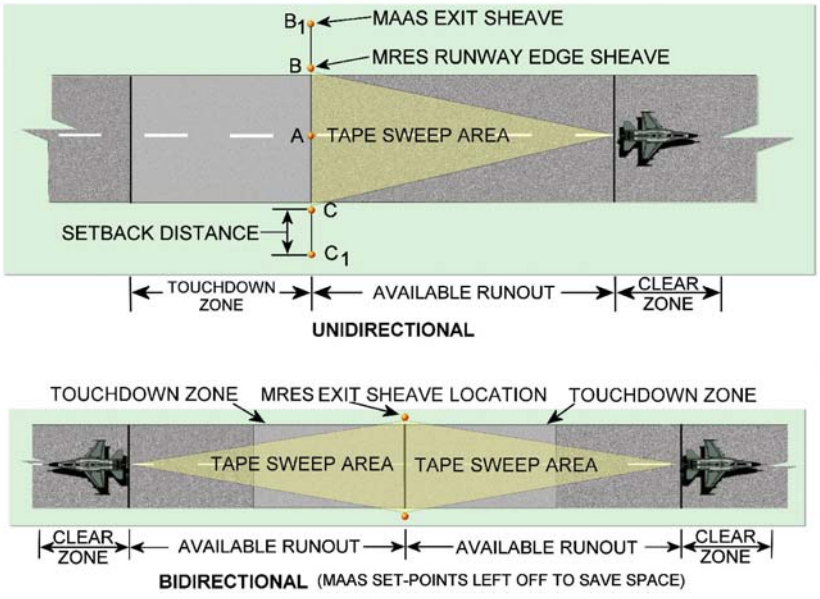
Notify Airfield Operations of any system irregularities and/or obstructions on or near the runway.

4.2.1. Operational Requirements. Certain aspects of flying operations may dictate a specific arresting system installation configuration. Request information from Airfield Operations personnel about types of aircraft that will use the airfield; landing/takeoff speeds and weights; and whether or not the standard setback (275 feet from runway centerline) will be necessary. This information will help determine the temporary arresting system installation configuration.

4.2.2. Site Selection. Perform concrete installations on the runway surface, concrete pads, or a concrete surface with an asphalt overlay of one inch or less in thickness. In any case, check the anticipated site to verify that it meets all positioning requirements before attempting the installation. Perform soil installations on undisturbed surfaces, immediately adjacent to the sides of the runway or overrun. In addition to the requirements in paragraph 2.2.2., the selection of a runway site must consider the following three requirements.

4.2.2.1. On-runway requirements must provide enough room for the aircraft to land and arrest safely. Select a portion of the runway that allows for a touchdown zone, a tape sweep area, and an aircraft clear zone. For bidirectional installations, consider these distances in both directions (**Figure 4.3**). See paragraphs 1.3.1, 1.4.2, and 1.4.6 for more information on touchdown zones, tape sweep areas, and aircraft clear zones.

Figure 4.3. On-Runway Clear Space Requirement.



4.2.2.2. MRES installation site requirements must meet footprint and alignment requirements at the side or edge of the runway. The selected site should be relatively flat and should be clear of obstructions both above and below ground. The concrete and soil clear zones presented in **Figures 4.4** and **4.5** identify sufficient space to perform the installations, including any temporary alignment anchoring that may be required.

Figure 4.4. MRES Clear Zone, Concrete Installation.

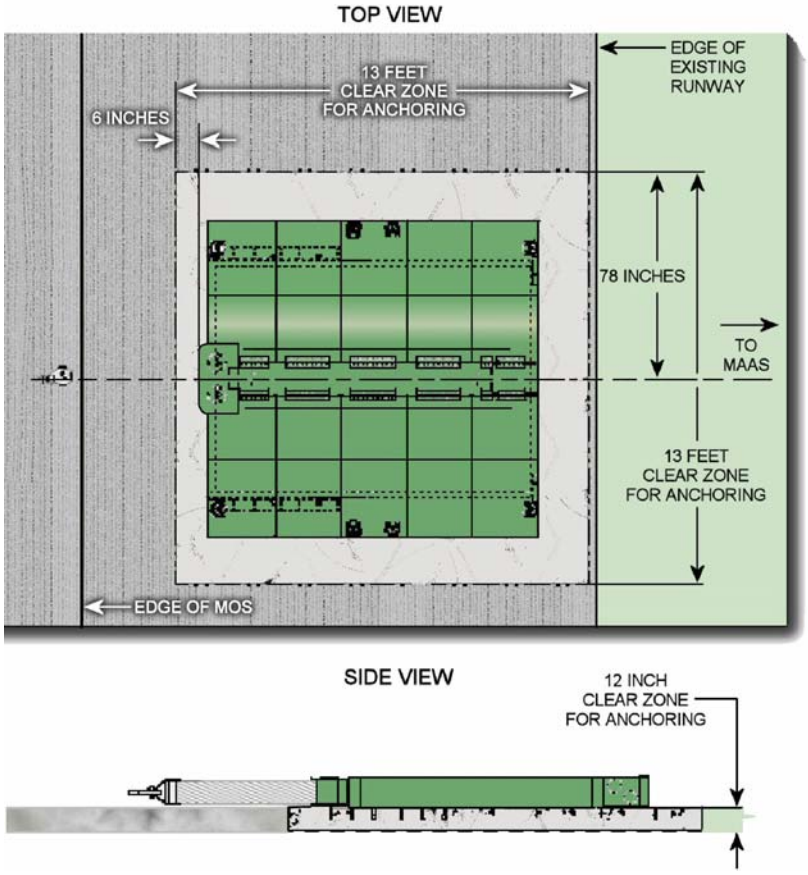
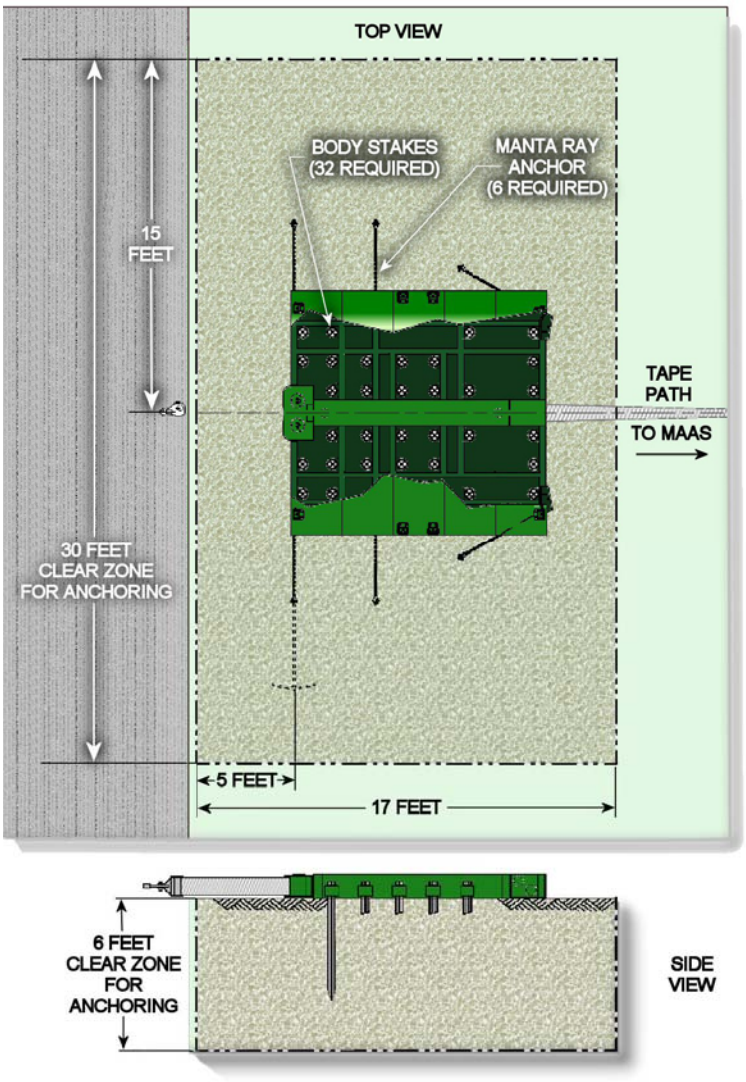


Figure 4.5. MRES Clear Zone, Soil Installation.



4.2.2.3. MAAS trailer setback requirements must meet footprint and alignment requirements when setting the trailers back from the sides of the runway. The selected site should be relatively flat and should be clear of obstructions both above and below ground. When selecting a site, take into account the footprint for the MAAS in the intended installation configuration, the alignment of the MAAS and MRES trailers, and achievement of the desired setback. The concrete and soil clear zones presented in **Figures 4.6** and **4.7** identify sufficient space to perform the installation.

Figure 4.6. MAAS Clear Zone, Concrete Installation.

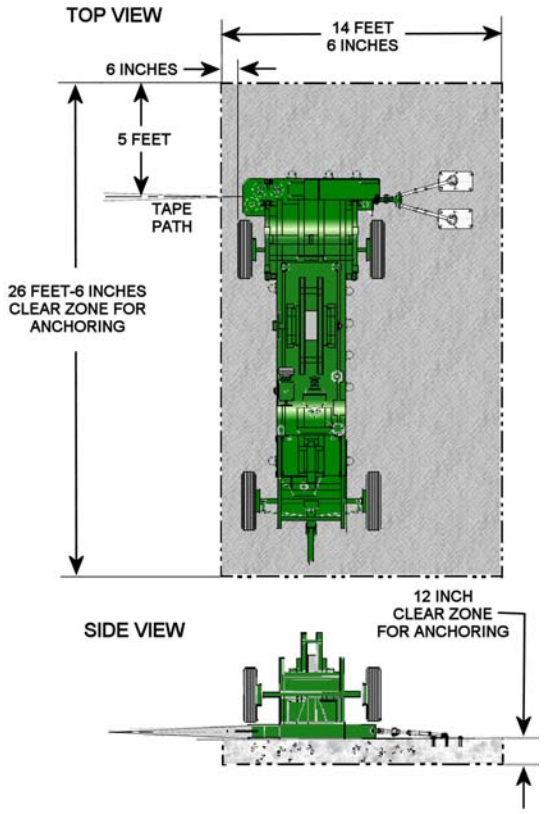
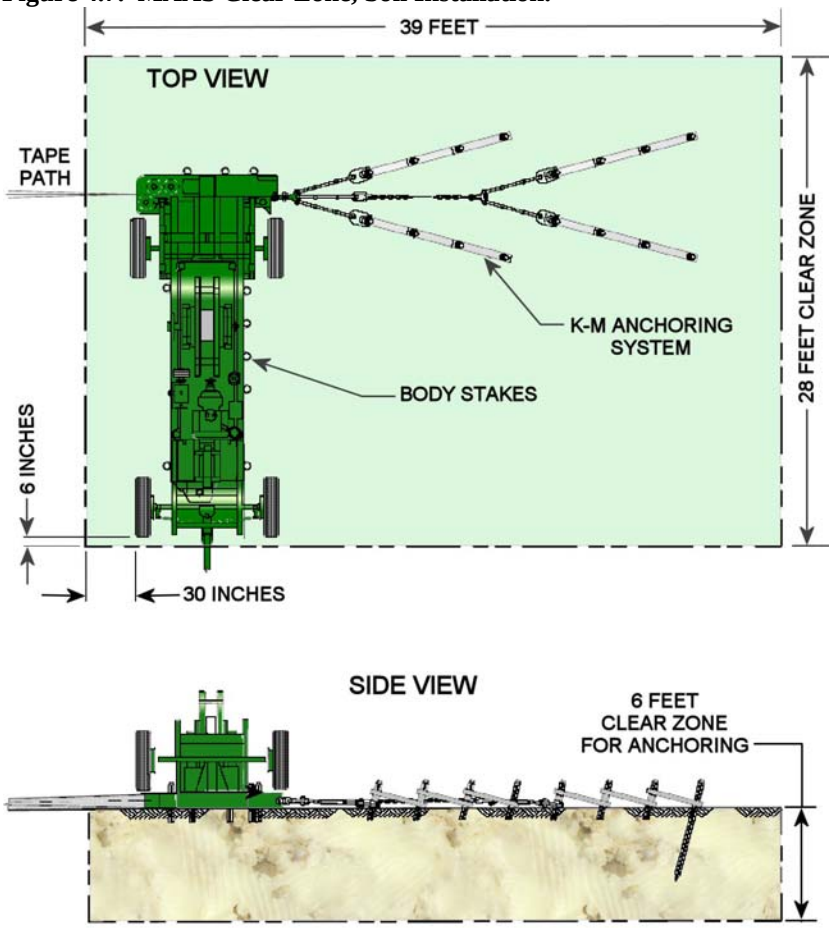


Figure 4.7. MAAS Clear Zone, Soil Installation.



WARNING

The tape stack-height dimension is a function of tape length (allowable aircraft run-out) and tape reel diameter. Following the installation of the MAAS and the MRES, the tape stack diameter must not exceed 1¼ inches. Failure to adhere to these limits will result in reduced run-out and possible danger to arrested aircraft and its crew.

CAUTION

Never shorten the setback distance based upon available tape length. If necessary, acquire new 1500-foot tapes for the setback installation.

4.2.2.3.1. Typical setback distance is 200 feet from runway edge. This may be less on runways wider than 150 feet; however, the minimum set back distance from runway centerline must be at least 275 feet or an airfield waiver will be required. The maximum allowable setback is 300 feet. Setback installations for shorter distances are acceptable in order to take advantage of existing site conditions. Bear in mind, however, that the point of the setback installation kit is to move the MAAS trailer away from the runway. Installations that achieve the standard 275-foot setback are most desirable.

4.2.3. Soil Conditions. Select appropriate Manta Ray anchors to suit the installation site based on the soil CBR. Ultimately, the 10,000 lbs proof load with the Load Locker must be achieved or a Portland cement concrete (PCC) foundation will be required or a new installation site must be selected.

4.2.3.1. Included are three types of manta ray anchors for different soil conditions: hard (CBR over 25), medium (CBR 25 or less), and soft (use only if unable to obtain 10K-lb proof load with smaller anchors) soil.

4.2.3.2. A full CBR test may not be possible during a deployment, but an Engineering Craftsman trained in the use of a dynamic cone penetrometer, which provides comparable readings, can determine soil condition.

4.2.4. Manpower Requirements. The recommended work force to accomplish installation is one barrier crew chief, one engineering assistant, five barrier crewmembers.

4.2.4.1. The engineering assistant, through use of surveying equipment, verifies that the site selected for installation meets the slope requirements and determines system component locations.

4.2.4.2. The crew chief has overall responsibility for the installation and must utilize all personnel effectively to minimize installation time. Different team members, as directed by the crew chief, should perform many of installation steps simultaneously. Training, practice, and safety are essential to minimize installation time.

4.2.5. Site Preparation. It may be necessary to perform minor leveling of the soil around and under the MAAS to prevent interference of the tape path. The edge of the runway surface must not extend higher than the MRES exit sheave (**Figure 1.9**). Additional filling, leveling, and compacting are required to bring the runway shoulder to an acceptable grade if it is lower than the runway surface. Clear and level the entire tape sweep area.

4.2.5.1. It is desirable that the centerline of the MRES sheaves project through the landing zone centerline plane 1 to 4 feet above the runway surface (see **Figure 1.10**). Never angle the MRES so that the projected tape path interferes with the runway surface. The crew chief must ensure appropriate surveying equipment and personnel are available to verify that the site meets these requirements.

4.3. Basic Configuration and Layout. After selecting a site based upon the requirements given above, the exact locations of system components must be determined and marked prior to installation.

NOTE: The set-point labels in this chapter differ from the previous chapters to keep the instructions consistent with those of the MRES T.O. 35E8-2-3-1.

4.3.1. Siting Centerline, Hook-cable Location, and Run-out Zone. Follow procedures in paragraphs 1.4.1 thru 1.4.6 of Chapter-1 to layout the runway centerline, hook cable location, and run-out zone.

4.3.2. Establish Perpendicular Lines. The preferred method to site system components and align the arresting system is for an engineering assistant to use surveying equipment. The following procedures are provided if an engineering assistant is not available.

NOTE: Before siting components, establish perpendicular lines to the runway centerline on which to mark points B and C by using the following procedures (**Figure 4.8**).

4.3.2.1. Obtain a small diameter stranded wire rope, at least 120 feet long. A wire rope can be borrowed from a bare-base structure erection kit.

4.3.2.2. Mark one end of the wire rope “A”.

4.3.2.3. Mark a point “A-1”, 30 feet from the end marked “A”.

4.3.2.4. Mark a point “A-2”, 50 feet from the point marked “A-1”.

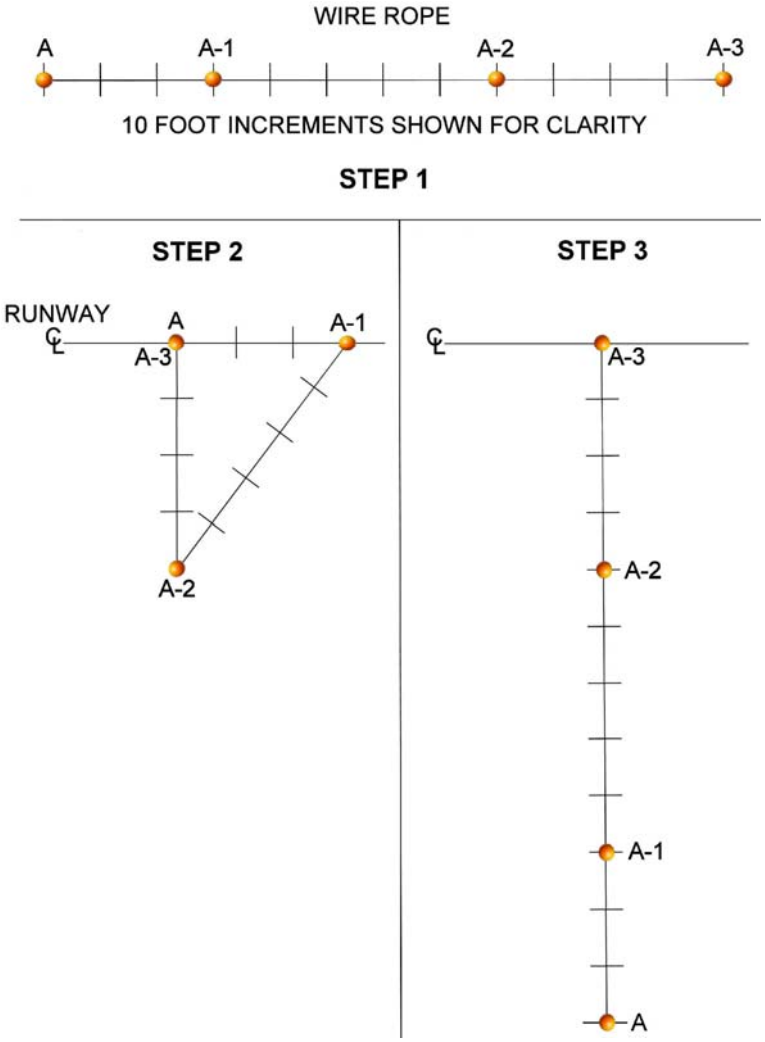
4.3.2.5. Mark a point “A-3”, 40 feet from the point marked “A-2”. Cut the wire rope at this point.

4.3.2.6. Place both ends at point A on the runway centerline (**Figure 4.3**). One person holds both ends in place.

4.3.2.7. Have a second person take the point marked A-1 on the squaring line and walk up or down the runway centerline until the segment of the line between points A and A-1 is taut. The person at point A should use line-of-sight to assist the second person in aligning point A-1 with the runway centerline.

4.3.2.8. Have a third person take point A-2 and walk toward the runway edge until the two remaining segments of line are taut. Temporarily mark the position of A-2.

Figure 4.8. Establishing Perpendicular Line with Wire Rope.



4.3.2.9. Points-A3 and -A2 must be held in place while the person at point A-1 returns to point A, and takes the end of the squaring line marked A, and walks past point A-2 to form a line perpendicular to the runway centerline.

4.3.2.10. Temporarily mark points A-2, A-1 and the end of the wire rope as shown in detail C of **Figure 4.8**.

4.3.2.11. Repeat the procedure for the opposite side of the runway, beginning at reference point A.

4.3.3. Siting the MRES Positions. Calculate the position for each MRES leadoff sheave as follows.

4.3.3.1. Determine the length of the hook cable. Add 15 feet to the length of the hook cable. Divide the sum in half. This number is the distance from point-A to point-B on **Figure 4.3**.

4.3.3.2. Starting at point A, measure the full distance determined in paragraph 4.3.3.1 along the perpendicular line on both sides of point A. Mark one point B and the opposite point C.

4.3.4. Siting the MAAS Positions. Measure the setback distance, as discussed in paragraph 4.2.2.3, from Marks B and C along the perpendicular lines. These are Marks B-1 and C-1, respectively (**Figure 4.3**).

4.3.5. Positioning MAAS Trailers. Locate one MAAS trailer on each side of the runway, parallel with the runway centerline, with the tape exit sheaves at points B-1 and C-1. Lower the MAAS trailers to the ground. When lowering, maintain cross-runway alignment of the trailer sheave exit points to within (+/-) 1 foot of the line perpendicular to the runway centerline.

4.3.6. Positioning MRES Trailers. Locate one MRES trailer on each side of the runway, perpendicular to the runway centerline, with the front tape sheaves at points B and C (**Figure 4.3**). Verify that the system falls within the alignment requirements (**Figure 1.11** and **2.2**).

WARNING

Due to the weight of the covers, it is preferable to lift and lower the covers using three workers. Keep fingers away from underneath the covers when lowering. When only two workers are available, minimize movement of the covers.

4.3.6.1. Remove ratchet straps from the MRES.

4.3.6.2. Remove stakes, tools, and all other hardware from storage on the MRES.

4.3.6.3. Remove three stake retainer plates from the MRES.

4.3.6.4. Remove load locker toolbox from the MRES.

4.3.6.5. Remove anchor weldments (9D00283-1 and 9D00283-2) from transport positions shown in **Figure 4.9**. Retain stake pockets and all hardware for re-use.

4.3.6.6. Install anchor weldments (9D00283-1 and 9D00283-2) in the installation positions shown in **Figure 4.9**. Re-install the stake pockets and secure all in place using the hardware removed in paragraph 4.3.6.5 above.

4.3.6.7. **FOR CONCRETE INSTALLATIONS ONLY:** Install installation brackets 9D00336-1 and 9D00336-2 onto the MRES by installing three screws, nuts, washers, and spherical washers into each bracket, as shown in **Figure 4.10**. Shown in the figure is installation bracket 9D00336-2; installation bracket 9D00336-1 is on the opposite side of the MRES.

4.3.6.8. Verify that the tires and tow bar jack are the only three items contacting the ground.

Figure 4.9. Anchor Weldments.

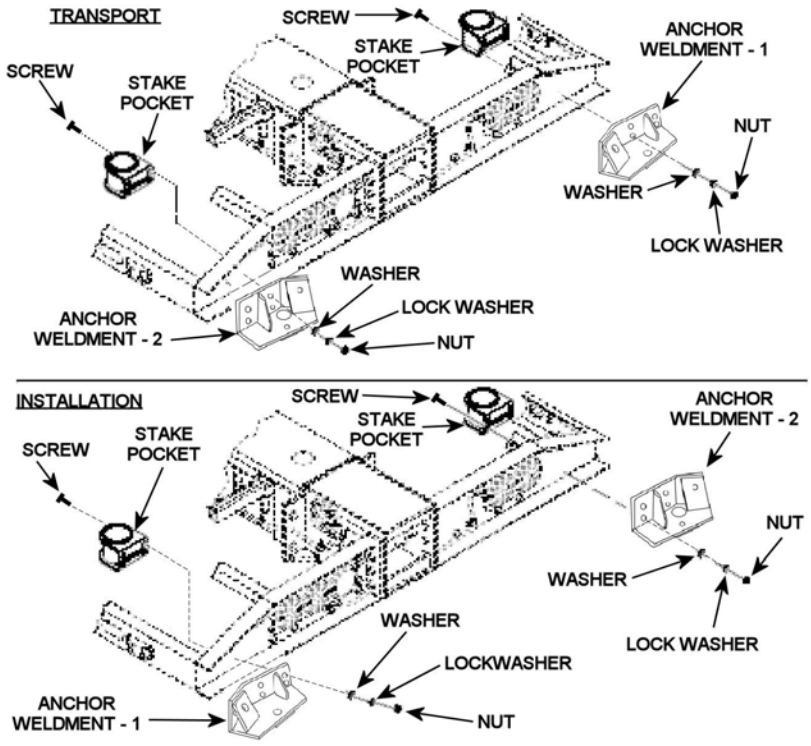
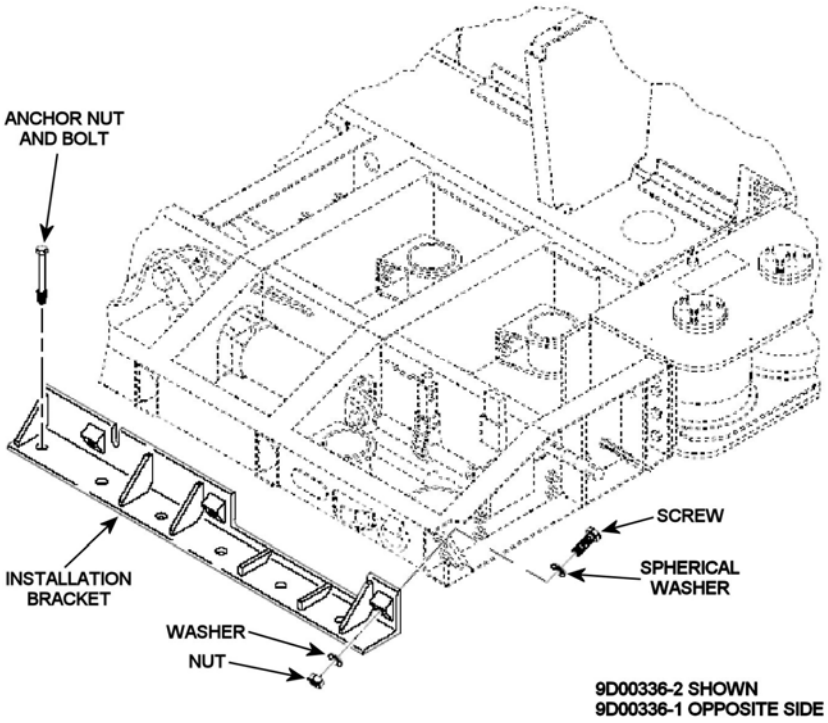


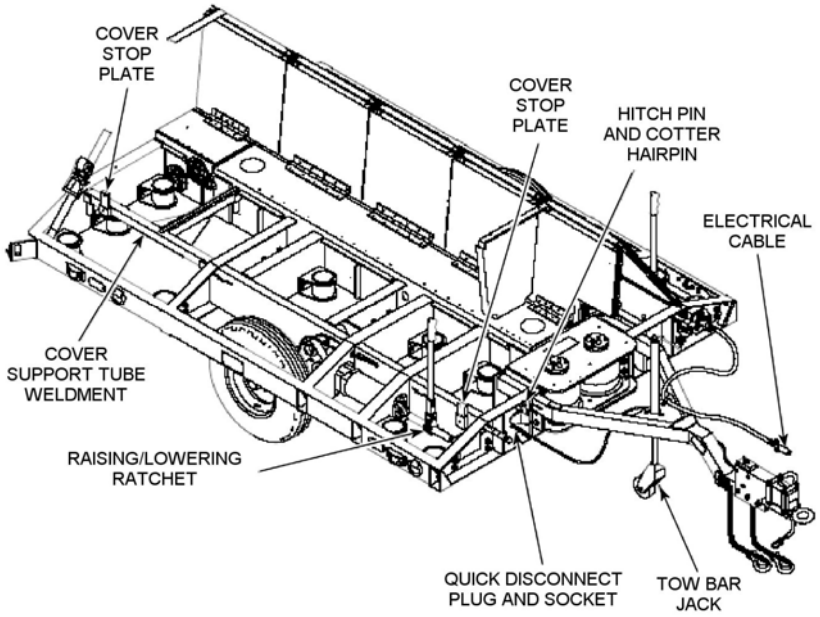
Figure 4.10. Installation Brackets.



***NOTE*:** Refer to **Figure 4.11** for paragraphs 4.3.6.9 thru 4.3.6.13.

4.3.6.9. At the front of the MRES, disconnect the brake quick disconnect plug from the quick disconnect socket. Cap the socket and plug to prevent line fouling. Disconnect the electrical cable from the MRES trailer.

Figure 4.11. Lowering MRES.



4.3.6.10. Using the ratchets in the front corners of the MRES assembly, lower the rear of the MRES assembly to the ground. To make each ratchet lower the MRES, engage its lower catch in the ratchet sprocket, then ratchet down. Lower the front end of the MRES assembly by using the tow bar jack. Attempt to keep the trailer level as the ratchets and tow bar jack lower the trailer. Crank the tow bar jack as far as it will go.

4.3.6.11. Remove cotter hairpin, then withdraw hitch pin from the tow bar and MRES body. Repeat for the other side of tow bar. Pull the tow bar straight forward to remove it from the MRES.

4.3.6.12. Use ratchets in front corners of each MRES assembly to raise wheel and tire assemblies to their maximum heights.

4.3.6.13. Remove lug nuts and washers and remove wheels from hubs. Set wheels aside and reinstall washers and finger-tighten lug nuts onto studs.

4.4. Aligning the System. Prior to installing the equipment, align the two MAAS trailers and the two MRES trailers.

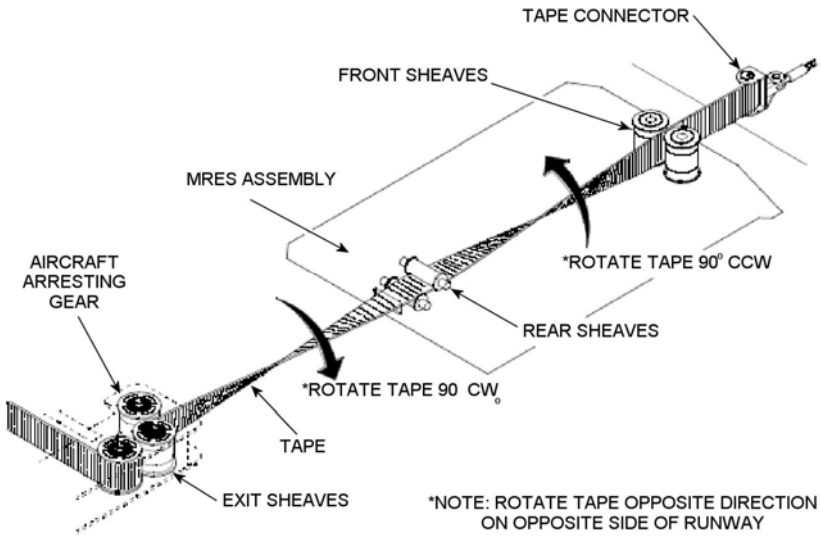
4.4.1. Preliminary Alignment.

4.4.1.1. Pull a sufficient length of tape from each MAAS trailer to reach the edge of the runway.

4.4.1.2. If installed, remove the tape connector in accordance with T.O. 35E8-2-10-1.

4.4.1.3. Reeve tape through MRES as follows (see **Figure 4.12**).

Figure 4.12. Reeving Tape.



4.4.1.3.1. Rotate tape 90° clockwise (CW) to horizontal and insert tape between the sheaves of the rear sheave assembly.

4.4.1.3.2. Remove plugs from inspection holes on frame weldment's center tube.

4.4.1.3.3. Rotate tape 90° counterclockwise (CCW) to vertical and insert tape between sheaves of the front sheave assembly.

4.4.1.3.4. Reinstall plugs in the inspection holes.

CAUTION
Verify that 90° tape twist on each side of runway between each aircraft arresting gear's exit sheaves and each MRES assembly's rear sheave is in the same direction, relative to the runway.

4.4.1.3.5. Repeat tape-reeving steps for the opposite side of the runway. This time, rotate the tape counterclockwise and clockwise, respectively.

4.4.1.4. Reinstall tape connectors onto tapes per T.O.35E8-2-10-1.

4.4.1.5. Install the hook cable assembly per T.O.35E8-2-10-1.

4.4.1.6. Perform rewind and pretension tapes per T.O.35E8-2-10-1.

4.4.1.7. The tensioned tape should form a straight line from the exit sheave of the MAAS, through the MRES trailer, across the runway, through the opposite MRES trailer, and into the opposite MAAS sheave. Reposition MRES assemblies as required to remove all bows from tape, while keeping front sheaves at set points B and C.

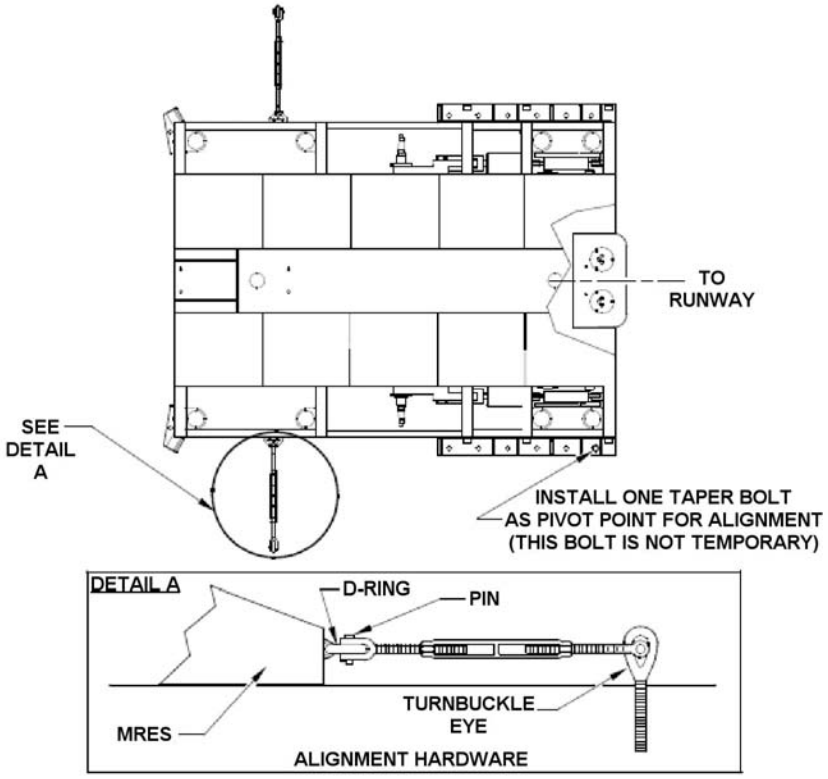
4.4.2. Install Concrete Alignment Anchors. The following procedures are used to install MRES alignment anchoring used for concrete installations only. If performing a soil installation, refer to paragraph 4.4.3.

4.4.2.1. Verify that the preliminary alignment is complete.

4.4.2.2. Using a 1-inch bit, operate the hydraulic hammer drill from the MAAS.

4.4.2.3. Using the installation bracket as a template, drill one 1-inch diameter hole in concrete surface to a depth of 7 inches (refer to **Figure 4.13** for hole location).

Figure 4.13. MRES Concrete Alignment Anchors.



4.4.2.4. Insert one taper bolt, nut, and washer into the hole to a depth of 1/2 the bolt length. Adjust the taper nut such that inserting requires tapping with a 4-pound hammer.

4.4.2.5. Acquire turnbuckle, part number 52B10525-5. Adjust the turnbuckle to approximately 30 inches.

4.4.2.6. At the port side of the MRES, attach one end of the turnbuckle to the rear D-ring on the MRES assembly. Position the turnbuckle at a right angle (90°) to the MRES assembly.

4.4.2.7. Mark the location at the end of the turnbuckle. Place the turnbuckle aside and drill a 1-inch hole to a depth of 7 inches at the marked location.

4.4.2.8. Insert a turnbuckle eye (P/N 70003-073) into drilled hole.

4.4.2.9. Attach the end of the turnbuckle to the turnbuckle eye using the turnbuckle pin. Secure in place using the hitch pin clip (P/N 70009-285).

4.4.2.10. Repeat steps in paragraphs 4.4.2.5 thru 4.4.2.9 for the D-ring located on the starboard side of the MRES trailer.

4.4.2.11. Adjust position of the turnbuckles to take up all slack. Do not tighten the turnbuckles to a point where they move the trailer.

4.4.3. Install Soil Alignment Anchors. The following procedures lists the steps to install the MRES alignment anchoring used for soil installations only. If installing on concrete installation, refer to paragraph 4.4.2.

4.4.3.1. Verify that the preliminary alignment is complete.

4.4.3.2. Using the MRES stake-driving tool, obtain the hydraulic hammer drill from the MAAS.

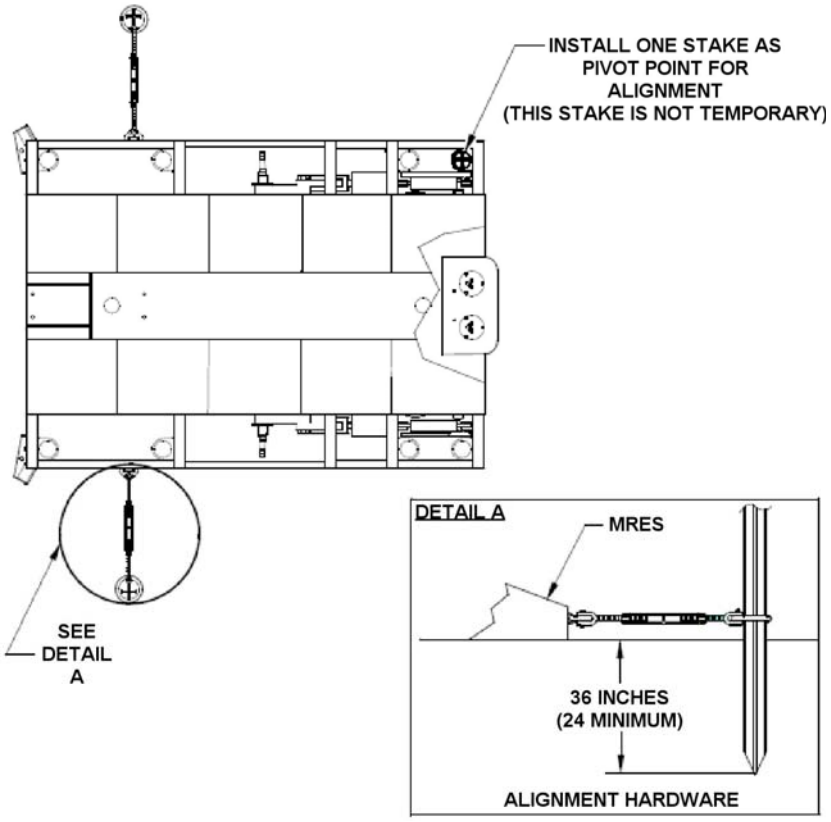
4.4.3.3. Drive one MRES stake into the stake pocket shown in **Figure 4.14**. Make certain that the MRES alignment does not change during installation of the stake.

4.4.3.4. Acquire turnbuckle, part number 52B10525-5. Adjust the turnbuckle to approximately 30 inches.

4.4.3.5. At the port side of the MRES, attach one end of the turnbuckle to the rear D-ring on the MRES assembly. Position the turnbuckle at a right angle (90°) to the MRES assembly.

4.4.3.6. Mark the location at the end of the turnbuckle. Place the turnbuckle aside and drive one stake to a depth of 36 inches (24 inches minimum) at the marked location.

Figure 4.14. MRES Soil Alignment Anchors.



4.4.3.7. Place weldless ring (P/N 70003-079) over end of the stake.

4.4.3.8. Attach the end of the turnbuckle to the weldless ring using the turnbuckle pin. Secure in place using the hitch pin clip.

4.4.3.9. Repeat steps in paragraphs 4.4.3.1 thru 4.4.3.8 for the D-ring located on the starboard side of the MRES trailer.

4.4.3.10. Adjust position of the turnbuckles to take up all slack. Do not tighten the turnbuckles to a point where they move the trailer.

4.4.4. Perform Alignment Pullout.

NOTE: Tapes should be pulled from the reel with the minimum brake pressure possible (shuttle valve OFF) to avoid moving the trailers. Before adjusting a turnbuckle when aligning the MRES during pullout, loosen the turnbuckle on the opposite side of the MRES.

4.4.4.1. Using a truck, or similar tow vehicle, slowly pull the tapes down the runway approximately 300 feet. Observe tape tracking at each MRES rear sheave assembly during the pullout. Adjust turnbuckles on MRES alignment anchors to center tape on rear tape sheaves during pullout.

4.4.4.2. Rewind tape per T.O.35E8-2-10-1.

4.4.4.3. Repeat steps in paragraphs 4.4.4.1 and 4.4.4.2 to pull tape out in the opposite direction.

4.4.4.4. When tape is centered, make certain that both turnbuckles are tight enough to prevent movement of the MRES.

4.4.4.5. Repeat steps in paragraphs 4.4.4.1 thru 4.4.4.3 for the MRES on the opposite side of the runway.

4.5. Install Concrete MRES Anchors. The installation items listed in **Table 4.1** are required for installation of the MRES on concrete. The items and quantities shown are for the installation of one MRES trailer, and supplied with the MRES. The list of tools required for installation of the MRES using concrete anchoring hardware is in **Table 4.2**. These tools are part of the MAAS, and not supplied with the MRES. The MRES also requires the use of the hydraulic power unit and tools from the MAAS.

4.5.1. Verify that the alignment anchors have been installed, and the pullout alignment has been performed.

4.5.2. Verify that the alignment anchor turnbuckles are tight enough to hold the MRES in position.

Table 4.1. MRES Concrete Installation Hardware.

Description	*Quantity*
Installation bracket	1
Installation bracket	1
Anchor weldment	1
Anchor weldment	1
Screw, hex head	6
Nut	6
Washer	6
Washer, spherical	6
Taper bolt	14
Storage bag	3

Table 4.2. MRES Concrete Installation Tools.

Description	*Quantity*
Ratchet, ¾” drive	1
Extension, 4”	1
Socket, 1-1/2” x 3/4” drive	1
Tape Measure, 100’	1
Adjustable wrench, 20”	1
Hammer, 4 lb	1
Taper bolt gauge	1
Hydraulic hammer drill	1
Helical bit	1
Tubing, round, 1-1/2”x24” long	1

4.5.3. Using each installation bracket as a template and a 1-inch bit and the hydraulic hammer drill from the MAAS, drill 1-inch diameter holes in the concrete to a depth of 7 inches. Insert a taper bolt, nut, and washer into each hole, to a depth of half the bolt length after drilling each hole to maintain bracket position. Adjust the taper nut such that inserting the bolt requires tapping with a 4-lb hammer. Installation brackets 9D00336-1 and 9D00336-2 require six holes each. Anchor weldments 9D00283-1 and 9D00283-2 require one hole each.

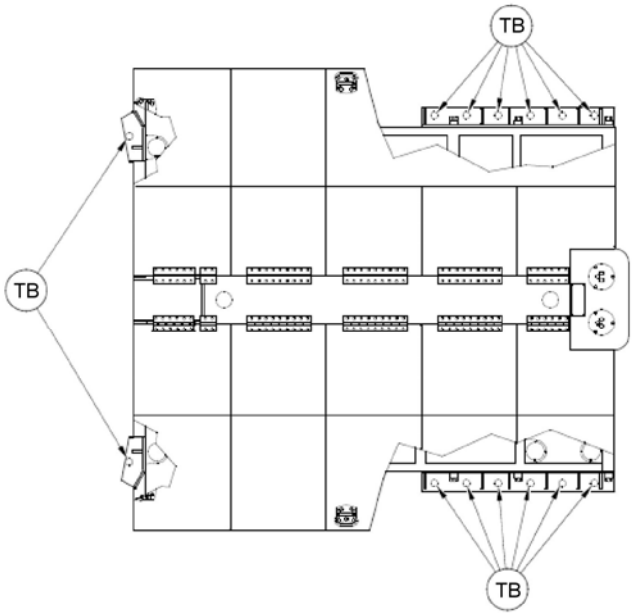
NOTE: If an asphalt overlay of 1 inch or less is present, drill through the asphalt and into the concrete to a depth of 6 inches.

CAUTION
Install all 14 anchor bolts to provide the proper safety margin.

4.5.4. Set the 3/8-inch clearance between the taper bolt heads and the installation bracket by using the taper bolt gauge.

4.5.5. Tighten down all bolts until seated firmly against the brackets. Install 14 anchor bolts at the locations shown in **Figure 4.15**.

Figure 4.15. MRES Concrete Anchoring.



4.5.6. Remove alignment turnbuckles from MRES and turnbuckle eyes.

4.5.7. Remove the turnbuckle eyes from the holes in the concrete.

4.5.8. Store alignment anchoring hardware.

4.5.9. Repair (plug) the holes in the concrete.

4.6. Install Soil MRES Anchors. The installation items listed in **Table 4.3** are required for installation of the MRES on soil. Items and quantities shown are for the installation of one MRES trailer, and supplied with the MRES. **Table 4.4** lists the tools required for installation of soil anchoring hardware. These tools are part of, and supplied, with the MRES. The MRES requires use of the MAAS tools and hydraulic power unit.

Table 4.3. MRES Soil Installation Hardware.

Description	*Quantity*
Stake	32
Anchor weldment	1
Anchor weldment	1
Turnbuckle eye	6
Extension nut	6
Spherical washer	6
Double clevis link	6
Storage bag	3
Manta ray anchor for hard soil	6
Manta ray anchor for medium soil	6
Manta ray anchor for soft soil	6
Cap screw	1
Flat washer	1

4.6.1. Verify that alignment anchors have been installed, and the pullout alignment has been performed.

4.6.2. Verify that the alignment anchor turnbuckles are tight enough to hold the MRES in position.

NOTE: Install MRES body stakes in stake pockets **after** tape pullout of approximately 300 ft in each direction, and verification of proper tape tracking.

Table 4.4. MRES Soil Installation Tools.

Description	*Quantity*
Stake driving head	1
Drive shank, 1-1/4 inch hex	1
Load locker base frame	1
Reversible wrench	1
Wrench	1
Shovel	1
Extension piece	3
Coupler	4
Drive tip	1
T-handle pin	1
Anchor setting bar	1
Load locker assembly	1
Jaw set	1

4.6.3. Staking of MRES Assembly.

WARNING

Wear adequate eye protection while driving stakes. Propelled rocks, metal fragments, and soil particles can damage unprotected eyes.

WARNING

When driving stakes, do not position hands near the stake driving head/stake interface; the stake driving head occasionally bounces off the stake. Insertion of fingers between driving head and stake can result in severe injury to personnel.

CAUTION
Place MRES stake driver over each stake before driving the stake into the ground. Make certain the driving head stays square to the stake during driving. Failure to use the stake driver or to keep it square may result in deformation of the stake head, making removal difficult.

4.6.3.1 Drive all 32 stakes through the frame weldment's 32 stake pockets to stake each MRES assembly to the ground. Move covers as needed to gain access to stake pockets.

4.6.3.1.1. Drive the 24 body stakes in the center sections of the MRES to a depth that allows 8-10 inches of the stake to remain exposed.

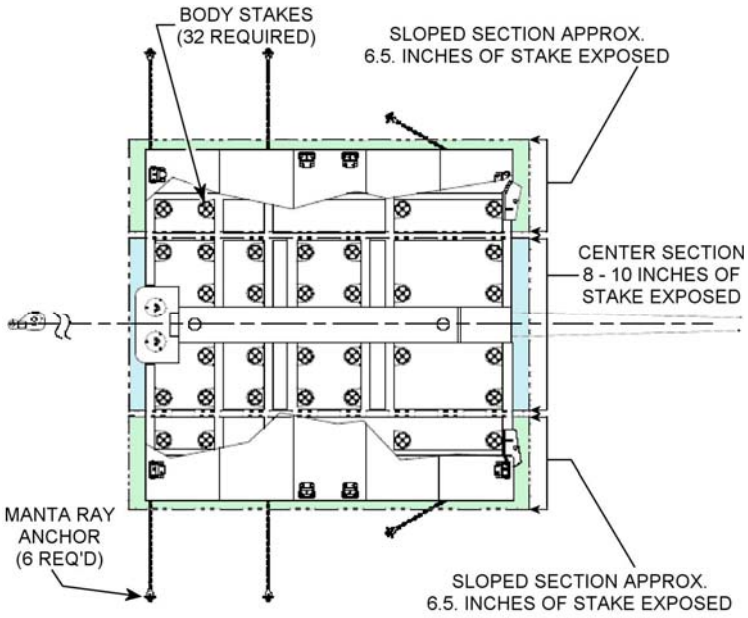
4.6.3.1.2. Drive the 8 stakes in the sloped sections to a depth that allows approximately 6-1/2 inches of the stake to remain exposed above ground. Make certain the stakes are driven deep enough to allow the covers to sit flush (**Figure 4.16**).

4.6.4. Manta ray anchoring of MRES Assembly (**Figure 4.16**).

WARNING
Wear adequate eye protection during anchoring of the MRES assembly. Propelled rocks, metal fragments, and soil particles can damage unprotected eyes.

WARNING
Wear gloves and hearing protection during the anchoring process. Anchoring operations pose injury hazards to unprotected hands and a potential for hearing loss.

Figure 4.16. MRES Soil Anchoring.

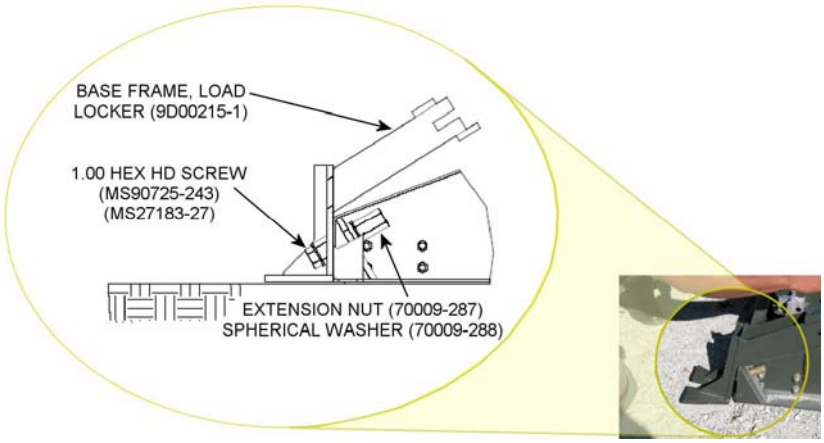


4.6.4.1. Locate the six anchoring points for the manta ray anchors on the frame weldment and on the anchor weldments.

NOTE: For hard soil (CBR over 25), use six 9D00204-1 manta ray anchor assemblies. For medium soil (CBR 25 or less), use six 9D00204-2 manta ray anchor assemblies. For soft soil (use only if 10K lb proof load cannot be obtained with smaller anchors), use the optional six 9D00204-3 manta ray anchor assemblies.

4.6.4.2. Place the load locker base-frame over the anchoring point on the frame (or anchor weldment) so its feet point away from the frame (or anchor weldment) and its "chute" hangs over the frame (or anchor weldment). Using the reversible wrench and the wrench, fasten the load locker base frame to the frame (or anchor weldment) with the hex head screw, washer, spherical washer and extension nut as shown in **Figure 4.17**.

Figure 4.17. Load Locker Base Frame Attachment.



4.6.4.3. Approximately one foot from the load locker base-frame, dig a small hole with the shovel.

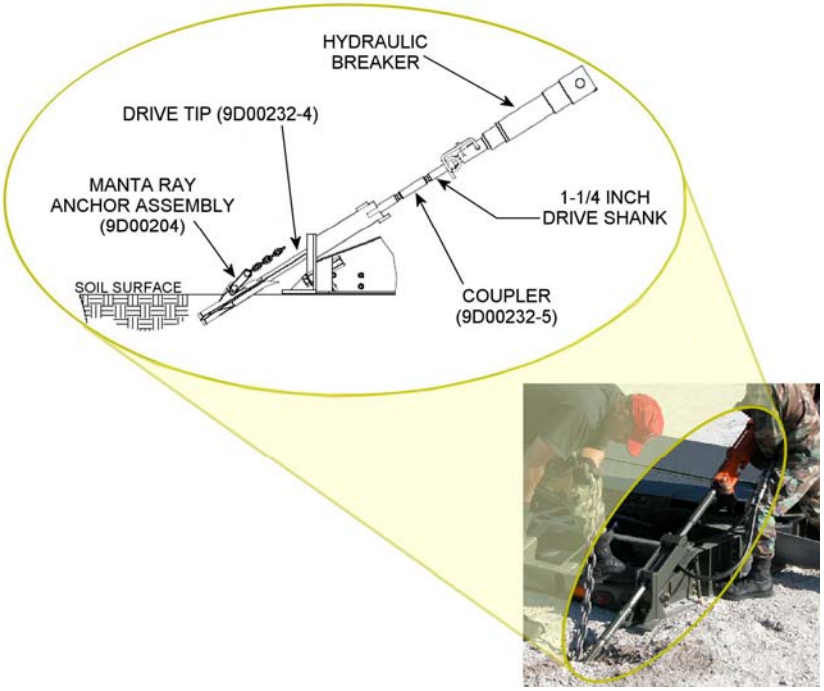
4.6.4.4. Place the appropriate manta ray anchor assembly (complete with chain and double clevis link) into the hole previously dug. Position the anchor at approximately a 30-degree angle to the ground, pointing away from the MRES assembly. Position the anchor so that the double clevis link and chain are on the top surface of the anchor. Lay out chain so it can follow the anchor into the ground without catching or binding.

***NOTE*:** One person should hold tension on the end of the chain while the driving the anchor into the ground. Doing so will provide a more accurate indication of when the anchor has been driven to the proper depth.

4.6.4.5. Lay out the stinger drive-gad assembly. The assembly contains three extension pieces, four coupler pieces, a radiused drive tip, and a 1-1/4 inch drive shank (**Figure 4.18**).

4.6.4.6. Connect the radiused drive tip to the 1-1/4 inch drive shank with a coupler.

Figure 4.18. Drive Anchor.



4.6.4.7. Obtain a hydraulic power unit (HPU) and hydraulic breaker from the MAAS and insert the 1-1/4 inch drive shank in the hydraulic breaker.

4.6.4.8. Using the load locker base-frame as a guide, route the radiused drive tip into the driving socket of the manta ray anchor. An assistant may stabilize the anchor with his or her foot to help drive the anchor into the ground.4

WARNING

Take care not to injure the assistant's foot when driving manta ray.

NOTE: If an underground object halts progress for two minutes or more, relocate the anchoring point. It may be possible to get the anchor out of the ground by keeping the drive gad assembly in the anchor and pulling gently with the chain.

4.6.4.9. Use hydraulic breaker to drive manta ray anchor assembly into the ground. Stop when first coupler penetrates the ground.

NOTE: Do not remove the stinger drive-gad assembly from the manta ray anchor assembly. The drive-gad assembly pieces have reverse threads, and are removed by unscrewing. The drive-gad assembly is **NOT** fastened to the manta ray anchor, and will be pulled out of the anchor if the drive-gad assembly pieces are pulled on. Do not remove the drive gad assembly from the manta ray anchor until the anchor has been fully driven to the desired depth.

4.6.4.10. Separate the hydraulic breaker from the 1-1/4 inch drive shank. Do not remove the stinger drive-gad assembly parts from the manta ray anchor assembly.

CAUTION
Wear leather gloves when handling the breaker and drive-gad assembly. During installation, the breaker and pieces of the drive-gad assembly will be hot enough to cause burns.

4.6.4.11. Remove 1-1/4 inch drive shank from coupler and connect a second extension piece to the coupler. Use a third coupler to connect the 1-1/4 inch drive shank to second extension piece.

4.6.4.12. Insert the 1-1/4 inch drive shank into hydraulic breaker. Use the hydraulic breaker and the stinger drive-gad assembly parts to drive the manta ray anchor assembly further into the ground. Stop when the second coupler penetrates the ground.

4.6.4.13. Separate the hydraulic breaker from the 1-1/4 inch drive shank. Do not remove the stinger drive-gad assembly parts from the manta ray anchor assembly.

4.6.4.14. Remove the 1-1/4 inch drive shank from the coupler and connect a third extension piece to the coupler. Use a fourth coupler to connect the 1-1/4 inch drive shank to the third extension piece.

4.6.4.15. Insert the 1-1/4 inch drive shank into the hydraulic breaker. Use the hydraulic breaker and stinger drive-gad assembly parts to drive the manta ray anchor assembly further into the ground. Stop when only six links of the chain are above ground (provide tension on the chain by hand while the anchor is being driven into the ground to ensure there is no slack in the chain when checking for the six links).

NOTE: If the drive-gad assembly does not break free (such as when rocks lodge against the drive-gad assembly in dry soil or if soft soil and mud sag around the drive-gad assembly), remove hydraulic breaker from the 1-1/4 inch drive shank. Separate the drive gad at the third coupler. Install gad extractor bar in third coupler, then use the load locker assembly to pull the drive gad assembly free.

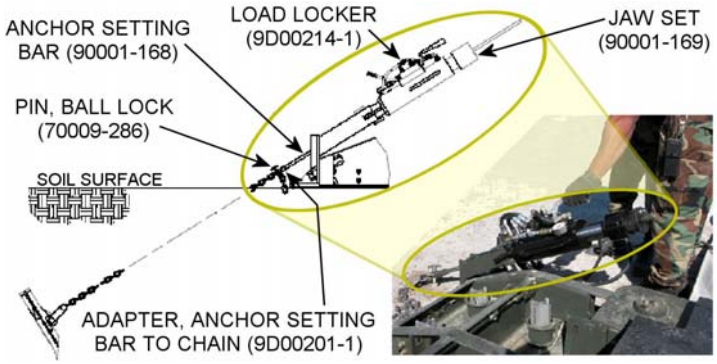
4.6.4.16. Pull upward on the hydraulic breaker to remove the drive-gad assembly parts from the manta ray anchor assembly. If the drive gad assembly does not break free immediately, pull up on the hammer while engaging the trigger to “creep” the drive gad assembly up and out of the anchor.

4.6.4.17. Remove the T-handle pin from the anchor-setting bar, and then insert the anchor-setting bar through the “chute” in the load locker base (**Figure 4.19**).

4.6.4.18. Attach the anchor-setting bar to the end of the chain by using the T-handle pin.

4.6.4.19. Slide the load locker assembly down over the anchor-setting bar until the “ears” on the load locker rest in the matching slots in the load locker base.

Figure 4.19. Pivot Anchor with Load Locker Assembly.



4.6.4.20. While pulling upward on the end of the anchor-setting bar until the anchor chain is tight, place the jaw set in position around the anchor-setting bar and push downward until the jaws are firmly in position on the top of the load locker.

4.6.4.21. Disconnect HPU hydraulic lines from hydraulic breaker. Connect them to the fittings on the load locker assembly.

4.6.4.22. Move the valve handle on the load locker assembly to the up position. The load locker pulls up on the chain once, and then stops.

NOTE: The relief valve on the load locker can be set to open at 10,500 PSI, which will "automatically" hold pressure constant. Refer to the manufacturer's manual for instructions.

4.6.4.23. Check the gauge reading on the manta ray load locker assembly. The desired reading on the gauge is 10,000 pounds. A gauge reading at or above the minimum must be held for one minute to assure that the anchor has anchored firmly enough in the ground to meet specifications. During the one-minute test period, the anchor-setting bar shall not move more than 1/2 inches.

4.6.4.23.1. Repeat steps 4.6.4.22 and 4.6.4.23 above until the gauge indicates the desired value. If the anchor-setting bar moves more than 1/2 inch, the anchor pulls out before the 10,000 pounds is achieved, or if the 10,000

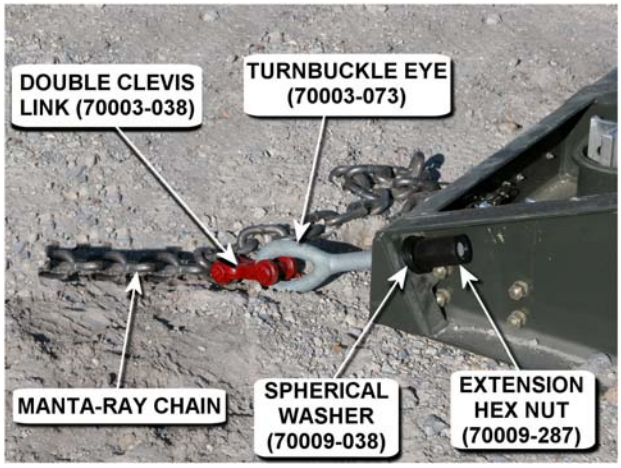
pounds cannot be reached, reposition the installation to an undisturbed location, and use a larger anchor.

4.6.4.24. Remove load locker assembly and anchor setting bar.

4.6.4.25. Using reversible wrench and wrench, remove cap screw, flat washer, spherical washer, and extension nut to free load locker base frame from MRES frame (or anchor weldment).

4.6.4.26. Install a turnbuckle eye, a spherical washer, and an extension hex nut. If working at a frame hole, place the turnbuckle eye so the eye points out and the extension hex nut and washer are inside the frame. If working at an anchor weldment hole, place the turnbuckle eye so the eye points out and forward, and the extension hex nut and washer are inward and rearward (**Figure 4.20**).

Figure 4.20. Frame to Anchor Connection.



***NOTE*:** It may be difficult to use the supplied wrench to secure some of the eyebolts. In this situation, use the tools provided in the MAAS tool kits.

4.6.4.27. Connect the appropriate link in the chain to turnbuckle eye with a double clevis link.

4.6.4.28. Turn turnbuckle eye so the eye opening faces the ground. Hold turnbuckle eye in this position with wrench while an assistant tightens the extension hex nut with the reversible wrench.

4.6.4.29. Repeat steps 4.6.4.2 thru 4.6.4.28 for remaining anchor points.

4.6.4.30. Remove the alignment turnbuckles from the MRES and stakes, remove the stakes from the ground, and then store alignment anchoring hardware.

4.7. Install MAAS anchoring. Follow the MAAS installation instructions in paragraphs 2.8.5 for concrete and 2.5 for soil.

4.8. Prepare System for Use.

4.8.1. Retrieve wheels and store flat on the ground under the cover support tube weldments in the rear corners of the MRES assembly.

4.8.2. Place a storage bag over each brake drum and hub assembly to keep them protected.

4.8.3. Lower the take-up assemblies so the covers will be able to close without contacting the brake drums.

4.8.4. Lower the covers as follows (refer to **Figure 4.11**).

CAUTION
Due to the weight of the covers, it is preferable to lift and lower the covers using three workers. When only two workers are available, minimize movement of the covers.

4.8.4.1. While two workers hold the covers of one side in position, remove hardware to free the two cover stop plates from their positions against the covers. Remove cover stop plates from the MRES. The cover stop plates can be reinstalled in the down position.

4.8.4.2. Have workers lower covers into position on the frame weldment.

4.8.4.3. Repeat steps 4.8.4.1 and 4.8.4.2 for the covers on the other side of the MRES assembly.

4.8.5. Using a tow vehicle, pull the tapes down the runway about 300 feet. Observe tape tracking through entire arresting gear system.

4.8.6. Rewind tapes per MAAS T.O.35E8-2-10-1.

4.8.7. Remove all hardware, parts, and installation equipment that was not used in the installation. Store these items together, so they will be readily available when the MRES is removed from service.

4.8.8. Perform proof loading and functional checkout per MAAS T.O.35E8-2-10-1.

4.8.9. Perform tape stack height measurement and replace tapes if they exceed the maximum allowable measurements.

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DCS/Logistics, Installations, and Mission Support (A4/7)

Attachment 1

GLOSSARY OF REFERENCES AND SUPPORTING INFORMATION

References

Air Force Publications

AFI 32-1042, *Standards for Marking Airfields*

AFI 32-1043, *Managing, Operating, and Maintaining Aircraft Arresting Systems*

UFC 3-535-01, *Visual Air Navigation Facilities*

T.O. 35E8-2-11-2, *Lightweight Fairlead Beam Configuration Set*

T.O. 35E8-2-3-1, *Operations Manual for the Mobile Runway Edge Sheave*

T.O. 35E8-2-3-11, *LL-1 Anchor Locking Kit Operation Manual*

T.O. 35E8-2-5-1, *Aircraft Arresting System Model BAK-12/E32A*

T.O. 35E8-2-10-1, *Operation and Maintenance Instructions, Arresting Systems, Aircraft, Mobile*

Department of Defense Documents

Joint Publication 1-02, *Dictionary of Military and Associated Terms*

Unified Facilities Criteria Documents

UFC 3-260-01, *Airfield and Heliport and Design*

Engineering Technical Letter (ETL) 98-10

Abbreviations and Acronyms

AF – Air Force

AFCESA – Air Force Civil Engineer Support Agency

AFSC – Air Force specialty code

AFI – Air Force instruction

AM2 – Aluminum matting

CBR – California bearing ratio

CCW – counter clockwise

CE – civil engineer(ing)

C_L – center line

CW – clockwise

DCC – disaster control center

ETL – engineering technical letter

FAA – Federal Aviation Administration

ft – foot

HPU – hydraulic power unit

IAW – in accordance with

ICAO – International Civil Aviation Organization

LWFB – lightweight fairlead beam

MAAS – mobile aircraft arresting system

MAJCOM – major command

MAJCOM/CV – Major Command Vice Commander

MOS – minimum operating strip

MRES – mobile runway edge sheave

PCC – Portland cement concrete

P/N – part number

PPE – personal protective equipment

psi – pounds per square inch

PSP – perforated Steel Planking

RRS – required runway setback

SRC – survival recovery center

T.O. – technical order

UFC – Unified Facilities Criteria

USAF – United States Air Force

Terms

Aircraft arresting system – A series of components used to engage and absorb the forward momentum of a routine or emergency landing or an aborted takeoff. (Joint Publication 1-02)

Bidirectional – An arresting system that can support aircraft operations in both directions.

Cable harmonics – The resulting cable rebound and flex when an aircraft's landing gear impacts the hook cable.

California bearing ratio (CBR) – A test for estimating the bearing value of sub-bases and sub-grades.

Energy absorber – The component of the arresting system that dissipates the kinetic energy of the arrested aircraft.

Lightweight fairlead beam (LWFB) – A configuration set designed to enhance the capabilities of the MAAS by presenting a significantly decreased arresting gear profile at the edge of the runway, thus reducing potential hazards to incoming and outgoing aircraft.

Mobile aircraft arresting system (MAAS) – A self-contained, trailer mounted BAK-12 aircraft arresting system that accommodates rapid installation during contingencies.

Mobile runway edge sheave (MRES) – A system on mobile trailers that provides a low profile runway edge sheave designed with metal covers that turn the profile of the MRES into a low ramp, which allows aircraft to safely rollover the MRES if they stray from the surface of the runway or overrun. The system allows the aircraft arresting gear to be set back from the runway, removing the equipment from the edges of the runway or overrun.

Overrun (USAF) – An area beyond the take-off runway designated by the airport authorities as able to support an airplane during an aborted take-off. The FAA/ICAO term for this is "stopway." UFC 3-260-01 identifies this area as one that prevents serious damage to aircraft that overrun or undershoot the runway.

Pendant – The part of an aircraft arresting system that spans the runway surface of flight deck landing area and is engaged by the aircraft arresting hook.

Setback distance – The total distance from the exit point of runway edge sheave to the exit point of the MAAS edge sheaves.

Stopway (FAA/ICAO) – An area beyond the take-off runway designated by the airport authorities as able to support an airplane during an aborted take-off. The USAF term for this is "overrun."

Tape stack height – The height of the fully rewound stacked tape on the tape reel, as measured from the outer wrap to the outer diameter of the reel plate.

Unidirectional – An arresting system that can support aircraft operations in one direction.

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